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FINAL

Pilot Study Report
Operable Unit No. 2 (Site 82)

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Prepared for

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Acronyms and Abbreviations

bgs	below ground surface
cVOC	chlorinated Volatile Organic Compound
DCE	dichloroethene
DHB	dehalobacter
DHC	dehalococcoides
DO	dissolved oxygen
DSM	desulfuromonas
ERD	enhanced reductive dechlorination
Fe(II)	ferrous iron
Fe(III)	ferric iron
ft/day	feet per day
ft/ft	feet per foot
gpm	gallons per minute
gpd/ft	gallons per day per foot
LTM	Long Term Monitoring
MCB	Marine Corps Base
MOB	methanotrophic bacteria
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
mg/L	milligrams per liter
ml	milliliter
MS/MSD	matrix spike/matrix spike duplicate
mV	milliVolt
NAIPs	natural attenuation indicator parameters
NCGWQS	North Carolina Groundwater Quality Standards
ORP	oxidation-reduction potential
OU	Operable Unit
PCE	tetrachloroethene
PVC	polyvinyl chloride
P&T	pump and treat
QA/QC	Quality Assurance/Quality Control

qPCR	real-time polymerase chain reaction
ROI	radius of influence
RI	Remedial Investigation
SOP	standard operating procedure
TCE	trichloroethene
TOC	total organic carbon
TOD	Toluene dioxygenase
VC	vinyl chloride
VOC	volatile organic compound

SECTION 1

Introduction

This report documents the pilot study conducted at Operable Unit (OU) No. 2, Site 82 at Marine Corps Base (MCB) Camp Lejeune located in Onslow County, North Carolina. The purpose of this pilot study was to evaluate the performance and effectiveness of the injection of a substrate blend (emulsified soybean oil and ethyl lactate) to stimulate enhanced reductive dechlorination (ERD) of chlorinated solvents in groundwater.

The following sections describe the site background, setting, and pilot study planning and implementation.

1.1 Site Background

Site 82 is located in the east-central portion of MCB Camp Lejeune ('Mainside'), approximately two miles east of the New River and two miles south of State Route 24, as shown on **Figure 1-1**. The site encompasses the wooded area between Lot 203 and Wallace Creek and is bounded by Holcomb Boulevard on the west, Wallace Creek on the north, Piney Green Road on the east, and Site 6 to the south.

Site 82 was identified in 1986 during an environmental investigation of Site 6. No organized disposal operations were documented at the Site; however, Site 82 was found to be randomly littered with debris. It appears Site 82 was used for disposal of miscellaneous debris from Lot 203, located southeast of Site 82 (Baker, 1993). There are no historical records indicating disposal of chlorinated solvents. However, chlorinated solvents have been found in groundwater as deep as 240 feet below ground surface (bgs). A total of nineteen volatile organic compounds (VOCs), including tetrachloroethene (PCE) and trichloroethene (TCE) have been detected in groundwater samples collected from Site 82.

Following completion of a Remedial Investigation and Feasibility Study, a Record of Decision was issued in September 1993 that specified the selected remedy as groundwater recovery and ex-situ treatment. Accordingly, in July 1996, a groundwater remediation system began recovering and treating impacted groundwater from a series of shallow and deep extraction wells.

Figures 1-2 and **1-3** depict the site map and pilot study layout.

1.2 Objective

The objective of the pilot study was to evaluate the viability of enhanced reductive dechlorination as a cost effective alternative to remediate groundwater impacted by chlorinated volatile organic compounds (cVOCs), in lieu of the on-going pump and treat (P&T) operations.

SECTION 2

Site Setting

2.1 Site Geology

At Site 82, the surficial soils consist of fine to coarse grained sands, silts, and clays. In several areas of the Site, the uppermost five feet of soil have been disturbed by Base activities and contains much fill material. Massive beds of silty sand and discontinuous sandy to clayey silts layers are present from ground surface to a depth of roughly 55 feet below ground surface (bgs). At a depth of approximately 55 feet bgs, site investigations encountered a continuous layer of heavily cemented silty sand and shelly limestone, roughly 10 feet in thickness. Massive silty sands interbedded with lenses of cemented sand and limestone lie beneath the cemented layer, extending to a depth in excess of 150 feet bgs. **Figure 2-1** depicts the alignment of geologic cross-section A-A', which is shown in **Figure 2-2**.

2.2 Site Hydrogeology

The Surficial aquifer at Site 82 occurs within the previously described silty sands, silts, and clays that overlie the heavily cemented layer encountered at roughly 55 feet bgs. The Castle Hayne aquifer exists below this same layer, extending to a depth of 250 to 300 feet bgs.

Based upon aquifer testing conducted during the RI (Baker, 1993), the hydraulic conductivity of the Surficial and Castle Hayne aquifers has been estimated to be approximately 3.4 feet per day (ft/day) and 35 ft/day, respectively. Due to the relatively low conductivity of the Surficial aquifer, groundwater pumping rates for the shallow recovery wells are low; in the range of one to four gallons per minute (gpm) or less. Pumping rates for the deep recovery wells installed within the Castle Hayne aquifer range from 30 to 150 gpm.

The direction of groundwater flow within the Surficial aquifer is northwest towards Wallace Creek, and groundwater flow in the Castle Hayne aquifer is west-southwest towards the New River. Water level data collected during the RI, suggests that there is no tidal influence on groundwater elevations in the area of Site 82 (Baker, 1993).

SECTION 3

Pilot Study

The following sections describe the planning and implementation of the ERD Pilot Study conducted at Site 82. **Table 3-1** provides a chronology of events during the pilot study.

TABLE 3-1
Chronology of Events
Pilot Study Report, Site 82, MCB Camp Lejeune

10 December through 13 December 2005	Installation of 6 intermediate-depth monitoring wells to serve as observation points following injection
January 2006	Deactivation of groundwater extraction well 6-DRW01
1 February 2007	Collection of baseline groundwater quality samples from 7 monitoring wells located in the immediate vicinity of the injection well (6-DRW01)
6 February through 9 February 2007	Injection of substrate material in 6-DRW01
21 February 2007	Installation of Bio-Traps
18 April through 19 April 2007	Post injection monitoring event (two months elapsed)
19 April 2007	Retrieval of Bio-Traps
13 June through 14 June 2007	Post injection monitoring event (four months elapsed)
14 August through 15 August 2007	Post injection monitoring event (six months elapsed)

3.1 Site Selection

Site 82 was selected as the location for the ERD pilot study due to the presence of on-going groundwater remediation activities utilizing P&T technology, and a desire to evaluate alternate, potentially more effective remedial technologies. Groundwater extraction well 6-DRW01 was selected as the injection well for use in the pilot study since it was believed to be located in close proximity to the contaminant source area, and its temporary deactivation would not adversely effect hydraulic plume containment.

Since the start up of the P&T system, groundwater samples have been collected on an annual basis from 6-DRW01 as part of the LTM program. **Table 3-2** presents a summary of the Long Term Monitoring analytical data for 6-DRW01; collected in September 2005 during active groundwater recovery operations.

TABLE 3-2
Summary of VOCs Detected in 6-DRW01
September 2005
Site 82, MCB Camp Lejeune, North Carolina

VOCs	NCGWQS (µg/L)	Concentration (µg/L)
Tetrachloroethene	0.7	790
Trichloroethene	2.8	9,200
cis-1,2-dichloroethene	70	1,600
trans-1,2-dichloroethene	100	330
Vinyl chloride	0.015	33 J

Note:

NCGWQS – North Carolina Groundwater Quality Standard
µg/L – micrograms per liter
J – Reported value is estimated

3.2 Enhanced Reductive Dechlorination Overview

Enhanced reductive dechlorination involves the transfer of electrons from an electron donor source to the cVOC, resulting in the sequential replacement of a chlorine atom with a hydrogen atom. An electron donor source is required for the reaction to occur. Potential electron donor sources include biodegradable organic co-contaminants, native organic matter, or substrates intentionally added to the subsurface. Deeply anaerobic (reducing) conditions are required for reductive dechlorination of many chlorinated VOCs. In addition, competing electron acceptors, such as dissolved oxygen, nitrate, nitrite, manganese [Mn(IV)], ferric iron [Fe(III)], and sulfate, must be depleted.

The principal anaerobic biodegradation pathway for reductive dechlorination of chlorinated ethenes is:

> *Tetrachloroethene (PCE) → Trichloroethene (TCE)→ cis-1,2-dichloroethene (cis 1,2-DCE) → vinyl chloride (VC) → ethene*

The transformation rates for each step vary but tend to become slower with progress along the breakdown sequence, often resulting in accumulation of cis-1,2-DCE and VC. Further breakdown from cis-1,2-DCE and VC to ethene varies and is based on site-specific conditions.

ERD of chlorinated VOCs is implemented by adding a suitable substrate to the subsurface. The introduced substrate serves two purposes: (a) depleting competing electron acceptors and creating strongly reducing conditions, and (b) providing an electron donor source for reductive dechlorination. Nutrients, lactate, emulsified oil, or other substrates are often used to enhance reductive dechlorination. These substrates provide a carbon source for microbial growth and electron donors, stimulating dechlorination.

3.3 Pre-Injection Activities

Prior to the initiation of the pilot study, several preparatory tasks were completed, including:

- Deactivation of recovery well 6-DRW01
- Installation of 6 intermediate-depth groundwater monitoring wells

3.3.1 Monitoring Well Installation

In December 2005, 6 intermediate-depth monitoring wells (designated as 6-GW47IW through 6-GW52IW) were installed using rotosonic drilling methods to a depth of 100 feet bgs. **Figure 1-3** illustrates the locations of these monitoring wells; in the vicinity of 6-DRW01.

The monitoring wells were constructed from two-inch diameter Schedule 40 polyvinyl chloride (PVC) pipe and five feet of 0.010-inch machine-slotted well screen. Wells were completed at grade with flush-mounted 8.5-inch diameter steel protective locking covers set in two foot square concrete aprons.

All monitoring wells were constructed and developed in accordance with the standard operating procedures (SOPs) as described in the Base Master Project Plans (CH2M HILL, 2005). Monitoring well boring logs are presented in **Appendix A**.

3.3.2 Baseline Monitoring

It was presumed that the on-going groundwater extraction operations could potentially elevate dissolved oxygen concentrations, resulting in slightly aerobic, oxidizing conditions in the Surficial and upper Castle Hayne aquifers. Therefore, the groundwater recovery well proposed for use as the pilot study injection well (6-DRW01) was deactivated for a period of approximately 12 months, beginning in January 2006, to allow groundwater geochemistry within the proposed injection zone to return to native conditions. The remaining recovery wells continued normal operations throughout the duration of the pilot test.

Prior to the start of the pilot study, the six newly installed monitoring wells (6-GW47IW through 6-GW52IW) and the injection well (6-DRW01) were sampled to establish baseline groundwater conditions. All groundwater samples were collected in accordance with the Base Master Project Plans (CH2M HILL, 2005), and analyzed for: VOCs (EPA Method 8260B), bromide, and natural attenuation indicator parameters (NAIPs) including: dissolved gases (RSK-175); nitrate, nitrite, sulfate, and chloride (EPA Method 300.0); sulfide (EPA Method 376.1); alkalinity (EPA Method 310.1); total organic carbon (TOC), total dissolved iron and manganese (SW-846 6010B). Water quality parameters, including DO, conductivity, pH, temperature, turbidity, and ORP were measured in the field.

3.4 Pilot Study Implementation

3.4.1 Substrate Description and Volume

A blend of emulsified oil and ethyl lactate was selected as the preferred amendment solution; approximately 262 gallons of emulsified oil (50 to 60%) was mixed on-site with

roughly 112 gallons of 100% ethyl lactate to create a blend of approximately 42% lactate in oil, by volume. Approximately 4.3 kilograms of bromide was also added to the substrate to act as a conservative tracer. During the injection process, the blended mixture was progressively diluted to 1.3% in water using potable water, obtained from a fire hydrant.

The target injection volume was one pore volume, which, assuming a 20-foot radius of influence (ROI) and an effective porosity of 0.15, was 28,185 gallons. The actual volume of solution injected was 28,140 gallons, over a period of three days. A total volume of 374 gallons of lactate/oil blend was injected, and approximately 500 gallons of chase water was used to help flush the solution out of the well screen after the substrate injection was complete.

3.4.2 Substrate Injection

Substrate injection commenced on February 6, 2007 and concluded on February 9, 2007. Dilution of the substrate was accomplished using a proportional feed system, which eliminated the need for a mixing tank and drew blended substrate directly from drums. A manifold, including a throttling valve, flow meter, and pressure gauge, was used to modulate and monitor solution flow rates during injection. A summary of injection stages and cumulative volume is presented in **Table 3-3.**

During the injection event, the six new monitoring wells (6-GW47IW through 6-GW52IW) were monitored for the presence of bromide tracer using a groundwater probe, equipped with an ion selective electrode. Water quality parameters were also monitored in these wells.

3.5 Field Microcosm Study

A field microcosm study was conducted using two groundwater monitoring wells situated outside of the proposed injection zone (6-GW47IW and IR06-GW27DW). On February 21, 2007, three "Bio-Trap" samplers were suspended in each test well: one control, one baited with 100% ethyl lactate, and one baited with the same emulsified oil/ethyl lactate blend injected in 6-DRW01. The control and ethyl lactate-baited traps were collected and analyzed approximately three months after emplacement, during the April groundwater monitoring event. The Bio-trap amended with the oil/lactate blend was collected and analyzed approximately six months after emplacement, because of limited solubility (and short term bioavailability) of the oil. The samplers were submitted to Microbial Insights for polymerase chain reaction (qPCR) analysis, to quantify known dechlorinating bacteria. Results of the field microcosm study are presented in **Section 3.7**.

3.6 Groundwater Monitoring

Following the substrate injection, post-injection groundwater monitoring was conducted at two-month intervals for a period of six months. Post-injection monitoring consisted of sampling the six new monitoring wells (6-GW47IW through 6-GW52IW) and the injection well (6-DRW01). The pilot study concluded with the third and final post-injection groundwater monitoring event.

All groundwater samples were collected in accordance with the Base Master Project Plans (CH2M HILL, 2005), and analyzed for: VOCs (EPA Method 8260B), bromide, and NAIPs including: dissolved gases (RSK-175); nitrate, nitrite, sulfate, and chloride (EPA Method 300.0); sulfide (EPA Method 376.1); alkalinity (EPA Method 310.1); TOC, and total dissolved iron and manganese (SW-846 6010B). Water quality parameters, including DO, conductivity, pH, temperature, turbidity, and ORP were also measured in the field.

Appropriate quality assurance/quality control (QA/QC) samples were submitted in accordance with all normal protocols. This included trip blanks (one per cooler with samples for VOC analysis), matrix spike/matrix spike duplicate (MS/MSDs) (5% of samples), duplicates (10% of samples), and equipment blanks (one per day of sampling).

3.6.1 Volatile Organic Compounds

During the baseline groundwater monitoring event, conducted in February 2007, the greatest concentrations of PCE were detected in monitoring wells 6-GW51IW and 6-GW52IW, while TCE concentrations were greatest in 6-GW49IW, 6-GW50IW and 6-GW51IW (**Figure 3-1** and **Table 3-4**). It is noteworthy that the VOC concentrations detected in the samples collected from 6-DRW01 decreased between one and two orders of magnitude following deactivation of the recovery well pump.

During the first post-injection monitoring event, conducted in April 2007, VOC concentrations detected in the sample collected from the injection well (6-DRW01) were significantly lower than those reported from the baseline monitoring event, as shown in **Table 3-4**. Wells 6-GW48IW, 6-GW49IW 6-GW50IW and 6-GW51IW also showed decreases in PCE and/or TCE. An increase in cis-1,2-DCE and VC was noted in 6-GW49IW and 6-GW51IW.

Comparison of the results from the second post-injection monitoring event, conducted in June 2007, to data from the April 2007 event generally revealed increases in concentrations of PCE and TCE, and in some instances to concentrations that exceeded the baseline data. Monitoring well 6-GW49IW exhibited significant increases in concentrations of TCE and VC over the previous monitoring event and the baseline event. However, the concentrations of VOCs detected in the injection well remained significantly below the baseline data.

The third and final post-injection monitoring event, conducted in August 2007, indicated relatively little change in concentrations compared to the previous event. The only exceptions were moderate increases of PCE and TCE in monitoring well 6-GW48IW and a significant decrease of TCE in 6-GW50IW (with a corresponding increase of cis-1,2-DCE). Concentrations of cis-1,2-DCE were reported in all wells, particularly 6-GW50IW and 6-GW51IW. Over the course of the pilot study, no changes were observed in the VOC concentrations detected in samples collected from upgradient monitoring well, 6-GW47IW.

3.6.2 Water Quality Parameters

In order to evaluate the distribution of the injected substrate and assess indicators of biological activity, field measurements of key water quality parameters were recorded in all seven monitoring wells associated with the pilot study, including DO, pH, specific conductivity, turbidity, temperature, and ORP. A summary of the water quality parameters recorded during the pilot test are presented in **Table 3-5**.

3.6.2.1 Dissolved Oxygen

Dissolved oxygen is the most thermodynamically favored electron acceptor used by microbes for the biodegradation of organic carbon. Generally, DO concentrations below 0.5 mg/L are required for anaerobic bacteria necessary for reductive dechlorination to be active. As the DO decreases within the aquifer, other electron acceptors (such as nitrate, ferric iron, or sulfate) may be used by microorganisms to facilitate reductive dechlorination reactions. Baseline DO concentrations in five of the seven monitored wells were less than or equal to 0.5 mg/L. With the exception of the June monitoring event, DO concentrations remained low throughout the study period.

3.6.2.2 Oxidation-Reduction Potential

The ORP of groundwater is a measure of electron activity and an indicator of the relative tendency of a solution to accept or transfer electrons. Reductive dechlorination is most efficient in the ORP range corresponding to sulfate reduction and methanogenesis [i.e. less than -100 millivolts (mV)].

ORP trends within the pilot study monitoring wells are presented in **Figure 3-1**. During the baseline monitoring event, ORP measurements in the pilot study monitoring wells ranged from -265 mV to 170 mV. With the exception of the injection well, ORP measurements generally decreased following substrate injection, leading to an ORP range at the conclusion of the pilot study of -233 mV to -82 mV.

3.6.2.3 Total Organic Carbon

Biodegradable organic carbon is utilized as an electron donor in the fermentation process that facilitates reductive dechlorination. The presence of TOC at concentrations greater than 20 mg/L indicates conditions conducive for reductive dechlorination to occur (USEPA, 1998; Wiedemeier et al, 1996). TOC was not detected at concentrations greater then 20mg/L during the baseline monitoring. Following substrate injection, TOC was detected in two wells, 6-GW49IW and 6-DRW01, at concentrations greater then 20 mg/L. The TOC concentration in injection well 6-DRW01 reached a maximum of 470 mg/L during the April 2007 monitoring event, while the TOC concentration at 6-GW49IW reached a maximum of 845 mg/L in June 2007.

3.6.3 Bromide

A bromide tracer was blended into the substrate prior to injection. **Table 3-6** provides a summary of the bromide concentrations detected during the monitoring events. Bromide was detected above background levels in the injection well (6-DRW01) and one hydraulically downgradient monitoring well (6-GW49IW) for a period of four months after substrate injection.

3.6.4 Natural Attenuation Indicator Parameters (NAIPs)

Natural attenuation indicator parameters (NAIPs), including nitrate, nitrite, total iron, dissolved iron, sulfate, sulfide, methane, chloride and alkalinity, were monitored in the seven pilot study wells throughout the course of the study. These parameters were

evaluated to determine if the conditions were favorable for biodegradation. **Table 3-6** presents a summary of the NAIPs**.**

Under anaerobic conditions, anaerobic bacteria utilize additional electron acceptors in the following order of preference: nitrate ("nitrate reduction"), ferric iron ("iron reduction"), sulfate ("sulfate reduction"), and carbon dioxide ("methanogenesis"). Reductive dechlorination has been demonstrated under nitrate-reducing and sulfate-reducing conditions, but is most likely to occur in methanogenic conditions. Because reductive dechlorination occurs under similar conditions to the processes mentioned above, the concentrations of constituents (such as nitrate, ferrous iron, etc.) can provide an indication of the general redox state of the aquifer and the potential for reductive dechlorination to occur.

When DO has been depleted, nitrate can be used as an electron acceptor in anaerobic degradation via denitrification. In denitrification, nitrate is reduced to produce nitrite. Therefore, decreased nitrate concentrations and increased nitrite concentrations relative to background indicate nitrate reduction is occurring. However, at concentrations greater than 1 mg/L, nitrate can compete with chlorinated hydrocarbons as an electron acceptor. Nitrate was not detected in any of the monitoring wells at Site 82. Nitrite was detected in monitoring well 6-GW49IW at concentrations ranging from 0.815 mg/L to 8.84 mg/L in April and June 2007, respectively. Nitrite was also detected in 6-DRW01 at a concentrations of 8.94 mg/L and 6.44 mg/L in April and June, respectively. The presence of nitrite and absence of nitrate in the 6-DRW01 and 6-GW49IW suggest that nitrate reduction is occurring.

In some cases, ferric iron [Fe(III)] is used as an electron acceptor during anaerobic degradation and reduced before sulfate. During this process (termed "iron reduction"), ferric iron is reduced to ferrous iron [Fe(II)]. Reduced ferric iron concentrations relative to background and ferrous iron concentrations greater than 1 mg/L are considered indicators of iron reduction. Ferrous iron concentrations can be estimated by subtracting detected ferric iron concentrations from total iron concentrations. Wells 6-DRW01 and 6-GW48IW detected both total and dissolved iron over 1 mg/L and increasing concentrations from the baseline monitoring event. The other wells did not indicate an increase in iron concentrations, total or dissolved, throughout the monitoring events.

After DO, nitrate, and iron have been depleted, sulfate may be used as the electron acceptor in anaerobic degradation. This process is termed "sulfate reduction" and results in the production of sulfide. However, sulfide will preferentially precipitate with available dissolved metals (for example, ferrous iron) before remaining dissolved in groundwater. Sulfate concentrations less than background are indicative of anaerobic degradation by sulfate reduction. Sulfate was detected four monitoring wells, 6-GW49IW, 6-GW50IW, 6-GW51IW, and 6-DRW01 and sulfide in one monitoring well, 6-DRW01. Sulfate concentrations were less than 20 mg/L in all wells, with concentrations ranging from 5.03 mg/L to 5.85 mg/L. Sulfide was found in only 6-DRW01 at 1.0 mg/L in August, see **Appendix B**.

After the preceding electron acceptors have been utilized, carbon dioxide can be used as the electron acceptor in anaerobic degradation. In this process, termed "methanogenesis", carbon dioxide is reduced to produce methane. The presence of methane in the aquifer is

indicative of strongly reducing conditions. In general, methane concentrations greater than background indicate methanogenesis is occurring. Reductive dechlorination is most efficient under methanogenic conditions. Methane was detected above the baseline concentrations in all but two wells, 6-GW51IW and 6-GW52IW. The presence of methane in excess of the baseline concentrations suggests that strongly reducing conditions were created within the pilot study area.

Chloride concentrations greater than background concentrations are indicative of the reduction of chlorinated solvent-related contamination is occurring (USEPA, 1998; Wiedemeier et al, 1996). A general decrease in chloride concentrations from the baseline concentrations was seen throughout the post-injection monitoring events.

3.7 Native Dechlorinating Bacteria

The previously referenced Bio_Traps™ were shipped to Microbial Insights for evaluation to determine the presence and relative abundance of indigenous dechlorinating bacteria. **Table 3-7** presents a summary of the dechlorinating bacteria detected at Site 82**.**

The target bacteria included: Dehalobacter (DHB), Dehalococcoides (DHC), Desulfuromonas (DSM), Methanotrophic bacteria (MOB)(able to cometabolically degrade some VOCs under aerobic conditions). DHB can indicate the transformation of TCE to cis-1,2-DCE. DHC, which are the only bacteria shown to be capable of complete degradation of PCE and TCE to ethane, grow slowly under strictly anaerobic conditions and may require several months to begin to thrive. DSM is also a strict anaerobic bacterium (Bitton, 1999).

DHB was reported to range from 787 to 219,000 cells/bead, with the highest detection reported in the baited control Bio_Trap™ and were found to be thriving in all traps. DHC ranged from less than 25 to 38.8 cells/bead, and DSM ranged from less than 50 to 824 cells/bead.

DHC populations were found to be quite limited, however DHC are known to take longer than the three months allotted during the pilot study to become thriving populations. The number of dechlorinators detected on the control trap was generally similar to the traps baited with the injected substrate, indicating that the naturally occurring conditions are adequate for dechlorinating bacteria to grow and thrive as well as they would with the addition of substrate. However, as shown by the low DHC and DSM detections, it may take up to six months to a year for dechlorinating bacteria to grow and thrive depending on the conditions.

SECTION 4

Conclusions

This pilot study successfully demonstrated that ERD is a viable remedial technology for the site-specific conditions encountered at Site 82. The following sections summarize the key findings and conclusions derived from the study.

4.1 Source Area Characterization

During design of the pilot study, it was assumed that the proposed injection well 6-DRW01 was located in the immediate vicinity of the source of the observed VOC impacted groundwater. **Table 3-2** summarizes the typical VOC concentrations detected in 6-DRW01 during active groundwater recovery operations.

During the roughly 12-month hiatus of groundwater recovery operations involving 6-DRW01 (in preparation for the initiation of the ERD substrate injection), VOC concentrations in this well decreased significantly, e.g. TCE decreased from 9,200 to 160 µg/L. The baseline monitoring indicated that the greatest VOC concentrations were reported for monitoring wells 6-GW50IW and 6-GW51IW, located west of 6-DRW01. This discovery suggests that groundwater pumping from 6-DRW01 is capturing impacted groundwater from nearby, but under static (no pumping) conditions the VOC concentrations in the immediate vicinity of this well are one to two orders of magnitude lower. The generally low ORP measured in wells 6-GW47IW, 6-GW50IW, and 6-GW51IW may also suggest that the source area is located to the west of 6-DRW01; the ORP measurements from wells 6-GW47IW, 6-GW50IW, and 6-GW51IW remained negative throughout the pilot study indicating the presence of naturally occurring reductive conditions.

In summary, it appears that while groundwater recovery from 6-DRW01 may be somewhat effective at removing contaminant mass, it is not an ideally located injection well for the purposes of remediation by means of ERD. Furthermore, this discovery questions the adequacy of previous source area characterization efforts with regards to the future evaluation of alternate remedial strategies.

4.2 Contaminant Degradation

Post-injection groundwater monitoring events detected TCE daughter products in each well, although byproduct production was most pronounced in monitoring wells 6-GW49IW, 6-GW50IW, and 6-GW51IW. The elevated concentrations of degradation byproducts indicate successful reductive dechlorination was identified at three out of six of the monitoring wells. The observed changes in groundwater geochemistry (low DO and negative ORP) indicate a shift towards a more reducing environment (such as the development of iron-reducing, sulfate-reducing, or methanogenic conditions). It should also be noted that groundwater quality in 6-DRW01, at the conclusion of the pilot study, met the NCGWQS.

4.3 Treatment Zone

Evaluation of the distribution of the bromide tracer suggests that the maximum extent of the treatment zone was approximately 20 feet hydraulically downgradient from the point of injection. Aside from the injection well, the bromide tracer was only detected in groundwater samples collected from monitoring well 6-GW49IW (within two months of injection), suggesting that the initial radius of influence was somewhat less than 20 feet and that the tracer was subsequently transported by means of advection. Therefore, the lateral and upgradient dimensions of the treatment zone are presumed to radiate less than 20 feet from the injection well.

Changes in ORP measurements may also be used to infer the extent of migration of the substrate. For example, monitoring wells 6-GW48IW, 6-GW49IW and 6-GW52IW exhibited post-injection decreases of ORP suggesting that these wells may have been influenced by the substrate injection.

The limited detection of the bromide tracer may also be due to several factors including: a) use of insufficient tracer volume, b) limited half-life of the bromide tracer may have lead to the degradation of the bromide tracer before reaching other wells, and c) heterogeneities within the treatment zone may have created preferential flow paths not intersected by the monitoring wells.

4.4 Dechlorinating Bacteria

The presence of the reductive dechlorination daughter products of TCE (cis-1,2-DCE and VC) in groundwater samples collected from monitoring wells 6-GW49IW and 6-GW50IW is considered to be an indicator that biologically mediated reductive dechlorination is occurring within the aquifer. The presence of elevated concentrations of VC in samples collected from 6-GW49IW is also considered to be significant, since it indicates the presence of bacteria capable of degrading cis-1,2-DCE. However, it is likely that the duration of the pilot test may not have been long enough to determine if vinyl chloride would degrade to ethane over time.

4.5 Cost

The cost to plan and implement the Site 82 ERD pilot was approximately $140,000, and included the following elements:

- Development of a project-specific work plan
- Installation and development of six 100 feet deep monitoring wells,
- Preparation of an Underground Injection Control permit application,
- Procurement and injection of the oil and lactate mixture,
- Mobilization for four groundwater monitoring events,
- Subcontracted laboratory services for VOC and microbial analyses,
- Preparation of a summary report

SECTION 5

Recommendations

Considering that a remedy is currently in place at Site 82, and is reportedly meeting the remedial objectives of plume containment and mass reduction, the decision to evaluate and pursue alternative remedial strategies should be weighed in terms of cost and benefit.

During this pilot study, it was noted that recovery well 6-DRW01 did not appear to be ideally located to efficiently extract impacted groundwater, potentially leading to greater time to reach cleanup goals. Based upon the available information, it is unknown whether the other groundwater recovery wells are more advantageously located. Consequently, it is recommended that before larger scale application of ERD technology is considered for Site 82, additional source characterization activities should be conducted to refine the conceptual site model and more accurately identify target treatment zones.

SECTION 6

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Tables

TABLE 3-3

Substrate Injection Flow Rates
Site 82 Pilot Study Report
MCB Camp Lejeune, North Carolina

Date and Time	Flow Rate (gpm)	Cumulative (gallons)
2/7/07 7:30	22	NA
2/7/07 11:15	22	4950
2/7/07 14:45	22	9570
2/8/07 7:50	22	14,100
2/8/07 8:50	22	15,404
2/8/07 12:50	22	20,684
2/8/07 14:20	22	22,440
2/9/07 8:50	12	25,260
2/9/07 9:50	12	25,980
2/9/07 10:50	12	26,700
2/9/07 12:50	12	28,140

gpm - gallons per minute

TABLE 3-4
Detected Concentrations of VOCs in Groundwater
Site 82 Pilot Study Report
MCB Camp Lejeune, North Carolina

Well ID	Sample Date	Concentration (ug/L)									
		PCE		TCE		cis-1,2-DCE		trans-1,2-DCE		VC	
NCGWQS (ug/L)		0.7		2.8		70		100		0.015	
06-DRW01	Sep-05	790		9200		1600		330		33	J
	Feb-07	15		160		150		36		1.6	J
	Apr-07	0.17	J	2		29	D	5		0.79	
	Jun-07	0.26	J	2.2		7.3		1.7		0.5	U
	Aug-07	0.28	J	1.9		10		1.7		0.74	
06-GW47IW	Feb-07	11		5.8		2.1		0.24	J	0.5	U
	Apr-07	32	D	6.2		3		0.49	J	0.5	U
	Jun-07	47	D	5.3		9.1		0.47	J	0.5	U
	Aug-07	18		5.5		20		0.5		0.5	U
06-GW48IW	Feb-07	53		120		40		4.2		4.2	U
	Apr-07	43		42		39		4.8		5.7	
	Jun-07	53		40		27		4.9		4.7	
	Aug-07	100		69		50		9.6		4.6	
06-GW49IW	Feb-07	63		1000	D	610		98		4.8	J
	Apr-07	21	U	21	U	810	D	18	J	85	
	Jun-07	22	J	1600		550		100		1100	
	Aug-07	50	U	1100		500		68		1300	
06-GW50IW	Feb-07	50	J	8300	D	1700		350		130	U
	Apr-07	50	U	1300		790		99		50	U
	Jun-07	130	J	7400		1900		260		250	U
	Aug-07	42	J	4500	D	2800	D	140		21	J
06-GW51IW	Feb-07	110		3800	D	520	D	210		5.5	J
	Apr-07	87	J	3200	D	1600		290		100	U
	Jun-07	220	J	6900		1000		290		250	U
	Aug-07	210	J	6200		990		380		17	J
06-GW52IW	Feb-07	96		150		130		20		4.2	U
	Apr-07	130	D	97		67		14		2.8	
	Jun-07	220		130		74		220		6.3	U
	Aug-07	240	D	130	D	100	D	22		3.5	
Average concentration over all wells	Feb-07	168		3225		657		145		26	
	Apr-07	52		667		477		62		35	
	Jun-07	99		2297		510		125		230	
	Aug-07	94		1715		639		89		192	

Note: NCGWQS - North Carolina Groundwater Quality Standards

D - Compound identified in an analysis at a secondary dilution factor.

J - Analyte present. Value may or may not be accurate or precise

U - The material was analyzed for, but not detected

TABLE 3-5
Summary of Water Quality Parameters
Site 82 Pilot Study Report
MCB Camp Lejeune, North Carolina

Well ID	Sample Date	Purge Volume (gallons)	Purge Rate (ml/min)	pH (SU)	Conductivity (S/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (^{o}C)	ORP (mV)
06-DRW01	Feb-07	340.0	--	7.73	0.241	0.0	0.36	18.2	-156
	Apr-07	350.0	--	5.97	1.02	24.0	0.00	18.57	-87
	Jun-07	330.0	--	5.90	0.886	132	5.20	19.41	-29
	Aug-07	380.0	--	7.89	0.900	7	0.42	19.6	-82
06-GW47IW	Feb-07	14.0	350.0	8.42	0.243	0.0	0.50	14.6	-265
	Apr-07	14.0	500.0	8.09	0.232	0.5	0.01	19.55	-265
	Jun-07	13.5	500.0	8.44	0.231	9.2	2.02	19.75	-254
	Aug-07	14.0	500.0	10.67	0.307	100	0.18	23.6	-233
06-GW48IW	Feb-07	13.0	350.0	7.52	0.339	0.8	1.72	16.5	9
	Apr-07	13.5	500.0	7.63	0.287	13.8	0.09	19.51	-155
	Jun-07	13.0	500.0	7.72	0.334	0.0	2.00	20.29	-152
	Aug-07	13.0	500.0	8.87	0.321	79	0.22	21.3	-138
06-GW49IW	Feb-07	13.0	400.0	7.52	0.099	11	0.09	16.31	59
	Apr-07	14.0	500.0	7.07	0.89	185	0.03	19.72	-185
	Jun-07	13.0	500.0	6.31	1.92	24.1	1.69	19.91	-112
	Aug-07	13.0	500.0	9.2	1.5	83	0.18	20.6	-157
06-GW50IW	Feb-07	12.5	350.0	7.93	0.009	0.1	0.18	14.78	-200
	Apr-07	13.5	500.0	7.96	0.36	8.9	0.00	19.71	-214
	Jun-07	13.0	500.0	8.30	0.215	90.7	1.70	20.98	-214
	Aug-07	13.0	500.0	10.23	0.909	0	0.20	22.4	-202
06-GW51IW	Feb-07	13.0	350.0	7.95	0.009	0.0	0.50	16.35	-189
	Apr-07	14.0	500.0	8.01	0.26	1.3	0.00	19.75	-233
	Jun-07	12.5	500.0	8.29	0.255	37.7	1.82	21.51	-213
	Aug-07	13.0	500.0	10.56	0.999	7	0.12	22.7	-214
06-GW52IW	Feb-07	13.0	400.0	7.43	0.398	3.1	0.80	17.9	170
	Apr-07	14.0	500.0	7.53	0.511	6.5	0.00	20.17	-128
	Jun-07	13.0	500.0	7.66	0.269	0.0	1.82	20.33	-151
	Aug-07	13.5	500.0	8.46	0.999	14	0.21	21.0	-135

ml/min - milliliter per minute
SU - standard unit
S/cm - Siemen per centimeter
NTU - Nephelometric turbidity unit
mg/L - milligram per liter
^{o}C - degree celcius
mV - millivolt

TABLE 3-6
Summary of Wet Chemistry Parameters
Site 82 Pilot Study Report
MCB Camp Lejeune, North Carolina

Well ID	Sample Date	Chloride (mg/L)	Ethene (mg/L)	Methane (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	TOC (mg/L)	Alkalinity (mg/L)	Total Iron (mg/L)	Dissolved Iron (mg/L)	Bromide (mg/L)
06-DRW01	Feb-07	3.70	2.0 U	0.4 JB	0.05 U	0.05 U	5 U	91.9	3.7 E	0 B	0.1 U
	Apr-07	2.80	2.0 U	2	0.05 U	8.94	470	587	28.9 N	26.9	2.89
	Jun-07	3.12	2.0 U	43 B	0.05 U	6.44	332	499	36.7	34	0.66
	Aug-07	2.03	2.0 U	79 BD	0.03 U	0.02 U	310	586	16.6	13.7	0.1 U
06-GW47IW	Feb-07	4.32	0.8 J	0.6 JB	0.05 U	0.05 U	5 U	101	1.2 E	0.6	0.1 U
	Apr-07	4.87	2.0 U	0.9 J	0.05 U	0.05 U	2.02 B	123	1.6 N	0.9	0.1 U
	Jun-07	4.35	2.0 U	1 B	0.05 U	0.05 U	5 U	110	1.5	0.7	0.1 U
	Aug-07	3.95	0.3 J	5 B	0.03 U	0.02 U	2.4 B	97.5	1.3	0.4 E	0.1 U
06-GW48IW	Feb-07	5.15	2.0 U	0.4 JB	0.05 U	0.05 U	5 U	156	0.1 E	0 B	0.1 U
	Apr-07	5.26	2.0 U	0.6 J	0.05 U	0.05 U	5 U	141	0.4 N	0 B	0.1 U
	Jun-07	4.02	2.0 U	1 B	0.05 U	0.05 U	5 U	137	0.2	0 B	0.1 U
	Aug-07	4.27	0.08 J	1 B	0.03 U	0.02 U	1.6 U	122	0.2	0 BE	0.1 U
06-GW49IW	Feb-07	5.03	2.0 U	0.5 JB	0.05 U	0.05 U	5 U	118	0.2 E	0 B	0.1 U
	Apr-07	3.30	2.0 U	2	0.05 U	0.815	392	380	3.4 N	0.9	7.94
	Jun-07	5.14	2.0	240 BD	0.05 U	8.84	845	1540	12.5	12.5	6.4
	Aug-07	3.22	0.6 J	300 BD	0.03 U	0.02 U	531	1760	8.5	6.3 E	0.1 U
06-GW50IW	Feb-07	7.60	0.7 J	0.5 JB	0.05 U	0.05 U	5 U	93.5	0.9 E	0.4	0.1 U
	Apr-07	6.72	0.6 J	3	0.05 U	0.05 U	5 U	103	0.9 N	0.4	0.1 U
	Jun-07	5.08	2.0 U	2 B	0.05 U	0.05 U	5 U	99.7	0.9	0.2	0.1 U
	Aug-07	4.81	0.2 J	3 B	0.03 U	0.02 U	1.6 U	89.4	0.6	0.3 E	0.1 U
06-GW51IW	Feb-07	6.32	0.9 J	0.6 JB	0.05 U	0.05 U	5 U	83.1	0.5 E	0.3	0.1 U
	Apr-07	6.97	2.0 U	0.4 J	0.05 U	0.05 U	5 U	108	0.9 N	0.4	0.1 U
	Jun-07	5.48	2.0 U	0.7 BJ	0.05 U	0.05 U	5 U	94	0.8	0.3	0.1 U
	Aug-07	5.05	2.0 U	0.3 BJ	0.03 U	0.02 U	1.6 U	86.9	0.7	13.7 E	0.1 U
06-GW52IW	Feb-07	5.23	2.0 U	0.7 JB	0.05 U	0.05 U	5 U	158	0.5 E	0.2	0.1 U
	Apr-07	5.33	2.0 U	0.4 J	0.05 U	0.05 U	5 U	153	0.4 N	0 B	0.1 U
	Jun-07	4.71	2.0 U	0.7 BJ	0.05 U	0.05 U	5 U	143	0.4	0.2	0.1 U
	Aug-07	4.72	2.0 U	0.4 BJ	0.03 U	0.02 U	1.6 U	121	0.3	0	0.1 U

Note: B - Analyte not detected above the level reported in blanks
D - Compound identified in an analysis at a secondary dilution factor.
J - Analyte present. Value may or may not be accurate or precise
U - The material was analyzed for, but not detected
E- (Inorganics) Estimated concentration due to interference
N- Spiked smapled recovery not within control limits

TABLE 3-7
Microbiological Populations
Site 82 Pilot Study Report
MCB Camp Lejeune, North Carolina

Sample ID	IR06-GW27DW-07B Control		IR06-GW27DW-07B Baited EL		IR06-GW27DW-07B Baited ELO		IR06-GW47IW-07B Control		IR06-GW47IW-07B Baited EL		IR06-GW47IW-07B Baited ELO	
Sample Date	4/19/07		4/19/07		4/19/07		4/19/07		4/19/07		4/19/07	
Chemical Name												
DHB	127,000	=	787	=	16,300	=	219,000	=	108,000	=	180,000	=
DHC	25	<	25	<	25	<	27.3	=	38.8	=	25	<
DSM	50	<	93.1	=	50	<	50	<	50	<	824	=
MOB	4,930,000	=	6,300,000	=	795,000	=	623,000	=	4,140,000	=	621,000	=
MOBI	4,840,000	=	6,230,000	=	603,000	=	618,000	=	4,120,000	=	618,000	=
MOBII	92,600	=	71,100	=	191,000	=	5,040	=	23,300	=	3,220	=
TOD	50	<	73,600	=	50	<	50	<	45,200	=	12,600	=

Notes:
Units in microbial cells per bead
DHB - Dehalobacter
DHC - Dehalococcoides
DSM - Desulfuromonas
MOB - Methanotrophic bacteria
TOD - Toluene dioxygenase

Baited EL - Biotrap baited with ethyl lactate
Baited ELO - Biotrap baited with the emulsified oil/ethyl lactate blend

Figures

\\Ariadne\groups\GIS\USNavFaceNGCom\315007CampLejeune\Projects\Sites6 and 82I\Figure_2_1_Base_Loc_Map.mxd

Legend
- Installation Area
- Site 82
- Limited Access Higwhay
- Highway
- Local Roads
- Cities

N
W E
S

0 4,500 9,000 13,500 18,000
Meters

Figure 1-1
Base Location Map
Site 82, Operable Unit No. 2
MCB Camp Lejeune, North Carolina

CH2MHILL

\\Ariadne\groups\USNavFaceNGCom\315007CampLejeune\Projects\Sites_6_and_82\Figure 1-2 - Site Map.mxd

Legend

- Environmental Restoration Area
- Deep Monitoring Well
- Intermediate Monitoring Well
- Shallow Monitoring Well
- Deep Recovery Well
- Shallow Recovery Well
- Approximate location of pilot study

N
W E
S

0 200 400 800 Feet

1" = 400 ft

Figure 1-2
Site Map
Site 82, Operable Unit No. 2
MCB Camp Lejeune, North Carolina

CH2MHILL

Aphrodite\proj\USNavFacEngCom\315007CampLejeune\Projects\Sites_6_and_82\Figure 1-3 Pilot Study Layout.mxd

Legend
- Deep Monitoring Well
- Intermediate Monitoring Well
- Shallow Monitoring Well
- Injection Well

N
W E
S

0 50 100
Feet

1" = 50 ft

Figure 1-3
Pilot Study Layout
Site 82, Operable Unit No. 2
MCB Camp Lejeune, North Carolina

CH2MHILL

Aphrodite\proj\USNavFacEngCom\315007CampLejeune\Projects\Sites_6_and_82\Figure 2-1 Cross_Section_Lcoation_map.mxd

Legend
- Injection Well
- Deep Monitoring Well
- Intermediate Monitoring Well
- Shallow Monitoring Well
- Cross-Section Location

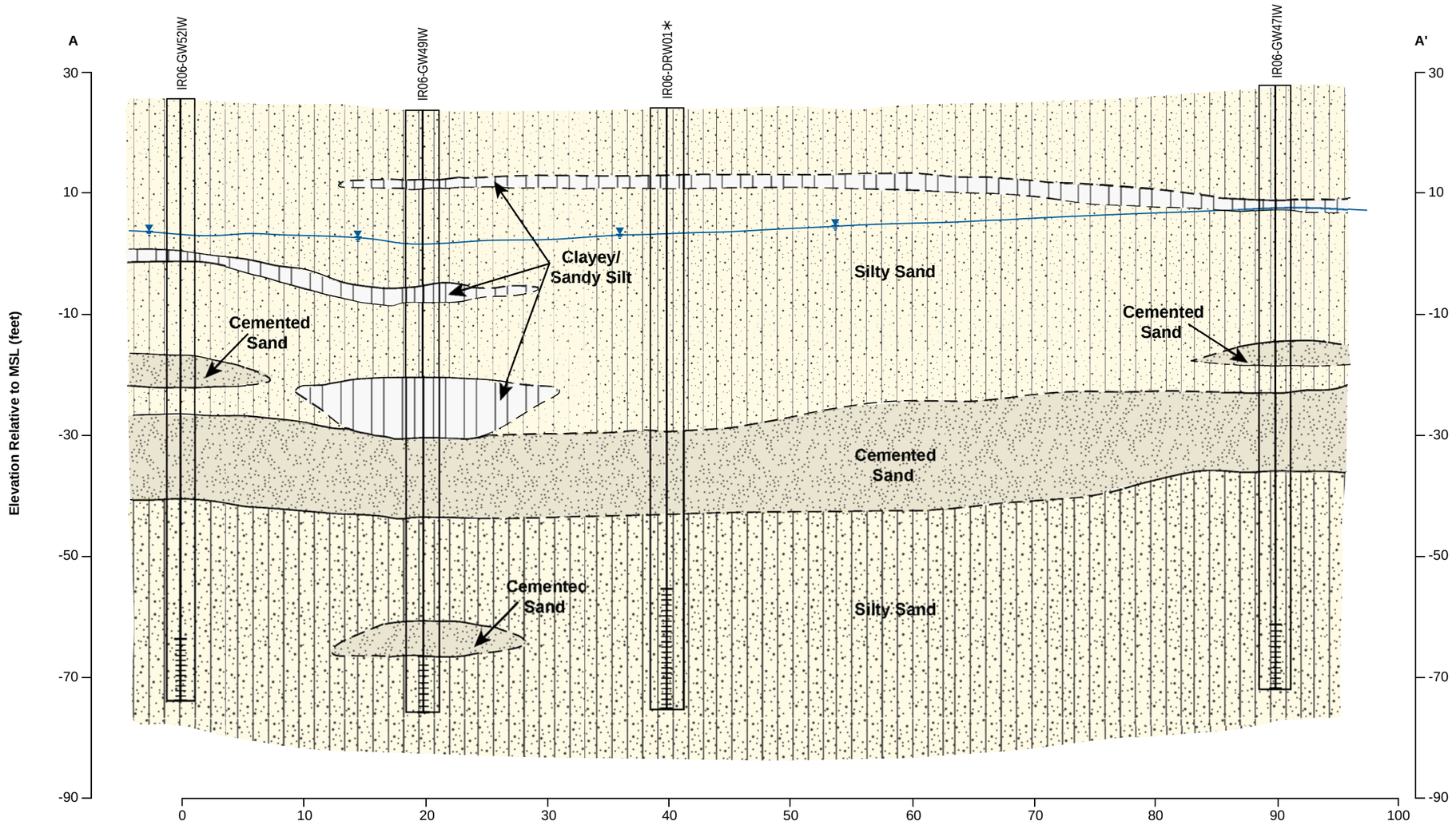
N
W E
S

0 50 100
Feet

1" = 50 ft

Figure 2-1
Cross-Section Location Map
Site 82, Operable Unit No. 2
MCB Camp Lejeune, North Carolina

CH2MHILL



Horizontal : 1" = 10'
Vertical: 1" = 20'
V.E. = 0.5x

LEGEND

- Clayey/Sandy Silt
- Silty Sand
- Cemented sand
- Screened Interval
- Inferred geologic contact
- Water table elevation

NOTE

1) The depth and thickness of the subsurface strata indicated on this section (profile) were generalized from and interpolated between test locations. Information on actual subsurface conditions apply only to the specific locations indicated. Subsurface conditions and water levels at other locations may differ from conditions occurring at the indicated locations.
2) All water levels were measured during sampling event in January 2005.
3) ∗ Boring log not available
4) IR06-DRW01 not used in cross-section development.

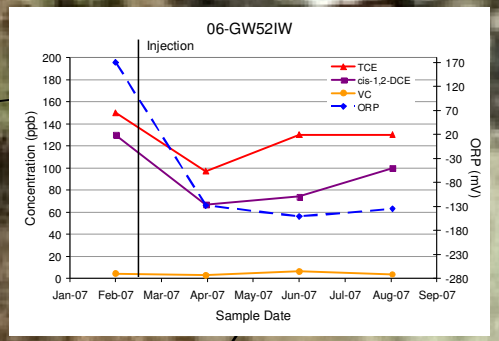
Figure 2-2
Geological Cross Section A-A'
Site 82, Operable Unit No. 2
MCB Camp Lejeune, North Carolina

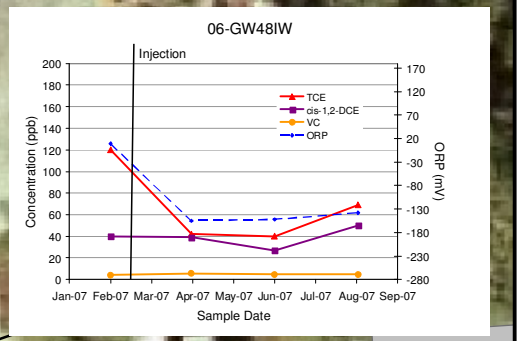
CH2MHILL

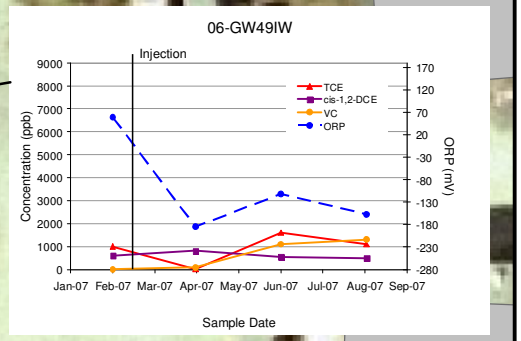
Aphrodite\proj\USNavFacEngCom\315007CampLejeune\Projects\Sites_6_and_82\Figure 3-1_Pilot_Study_Monitoring_Data.mxd

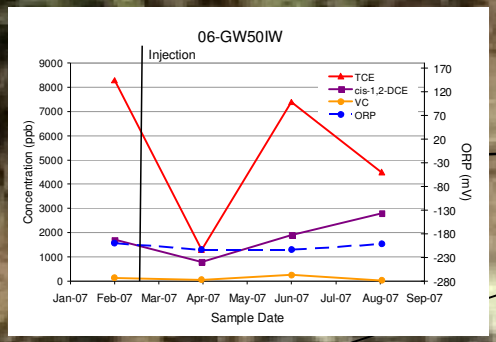
Note:

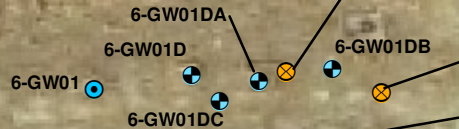
Monitoring Well	Distance in Feet from Injection Well (IR06-DRW01)
6-GW47IW	48
6-GW48IW	28.5
6-GW49IW	21
6-GW50IW	29.5
6-GW51IW	31.5
6-GW52IW	40

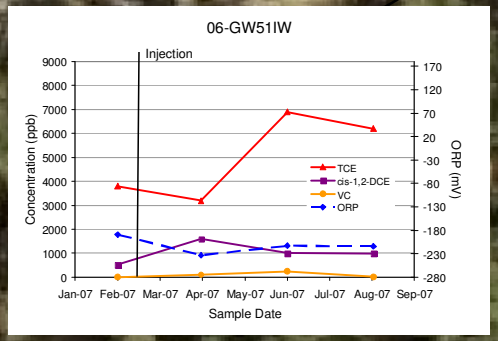


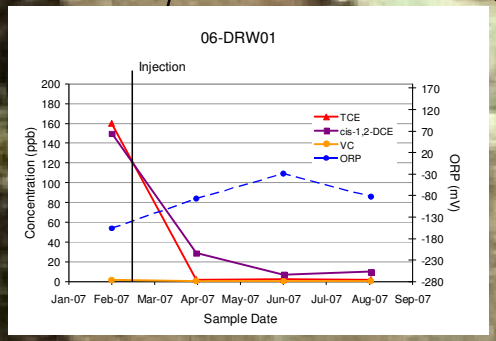


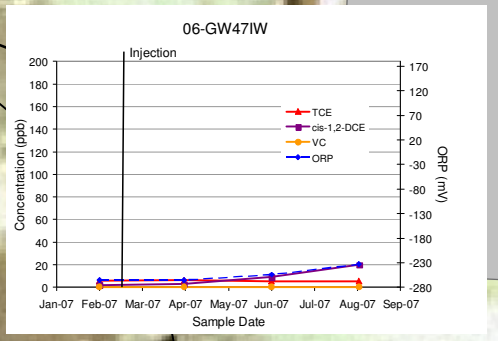












Legend
- Deep Monitoring Well
- Intermediate Monitoring Well
- Shallow Monitoring Well
- Injection Well

N
W E
S

0 50 100
Feet

1" = 50 ft

Figure 3-1
Pilot Study Monitoring Data
Site 82, Operable Unit No. 2
MCB Camp Lejeune, North Carolina

CH2MHILL

Appendix A

Boring Logs

CH2MHILL

Well Number: GW47IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/13/05 9:15 to 1:20

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
0				Ground Surface	0		
				0 - 3.0' - Silty Sand (SM), Medium sand, 10YR 3/8 yellowish brown, moist, loose	0		0' - 7.0' = 0.00 ppm
					-3		
				3.0' - 7.0' - Silty Sand (SM), Medium sand 10YR 7/4 pale brown, moist, very loose	3		
5					-7		
				7.0' - 10.0' - Silty Sand (SM), Medium sand 10YR 7/4 pale brown, moist, very loose	7		7.0' - 17.0' = 0.00 ppm
					-10		
				10.0' - 14.0' - Silty Sand (SM), Medium sand, 10YR 5/3 dark brown, moist, medium dense	10		
10					-14		
				14.0' - 17.0' - Silty Sand (SM), Medium sand, 10YR 7/1 light gray, moist to wet, loose	14		
15					-17		
				17.0' - 19.0' - Silty Sand (SM), Medium sand, 10YR 7/1 light gray, moist to wet, loose but 10YR 5/1 gray, saturated	17		18.0' = 2.0 ppm
					-19		
				19.0' - 20.5' - Clayey Silt (ML), 10YR 5/1 gray, moist, very stiff	19		20.0' = 2.7 ppm
20					-22		
				19.0' - 23.5' - Silty Sand (SM), 70% medium sand, 10 - 15% coarse sand, 7.5YR 6/8 reddish-yellow, moist, very loose	22		22.0' = 12.7 ppm
					-24		
				23.5' - 27.0' - Silty Sand (SM), Medium sandy, 10 - 20% silt, 10YR 4/1 dark gray, saturated, medium dense, small clayey silt lens at 26.0'	24		24.0' = 17.8 ppm
25							

CH2MHILL

Well Number: GW47IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/13/05 9:15 to 1:20

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
					-27		26.0' = 18.4 ppm
				27.0' - 30.0' - Silty Sand (SM), Medium sandy, 10 - 20% silt, 10YR 4/1 dark gray, saturated, medium dense, small clayey silt lens, but 10YR 3/1, gray	27		28.0' = 20.3 ppm
30					-30		
				30.0' - 32.0' - Silty Sand (SM), 10 - 15% silt, Gley1 5/1 greenish gray, saturated, loose	30		30.0' = 32 ppm
					-32		
				32.0' - 37.0' - Silty Sand (SM), Medium sand, 10YR 4/1 dark gray, saturated, loose, homogenous	32		32.0' = 64.0 ppm
							34.0' = 101 ppm
35							36.0' = 52.2 ppm
					-37		
				37.0' - 42.0' - Silty Sand (SM) Medium sand,10YR 4/1 dark gray, saturated, loose, homogenous	37		38.0' = 7.1'
40							40.0' = 4.0'
					-42		
				42.0' - 46.0' - Silty Sand (SM), Conglomerate, 10YR 7/1 light gray, saturated, very hard, solid, shells/fossils	42		42.0' = 22.1 ppm
							44.0' = 57.2 ppm
45					-46		
				46.0' - 47.0' - Silty Sand (SM), Medium sand, 10YR 4/1, dark gray, saturated, loose	46		46.0' = 93 ppm
					-47		
				47.0' - 50.5' - Silty Sand (SM), Medium sand, 10YR 4/1, dark gray, saturated, loose	47		48.0' = 12 ppm
50							50.0' = 13 ppm

CH2MHILL

Well Number: GW47IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/13/05 9:15 to 1:20

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
55				50.5' - 55.5' - Silty Sand (SM), 15 - 20% silt, crushed shell, Gley1 8/1 dark greenish gray, moist, very dense, many shells/fossils	-51 51		52.0' = 21.2 ppm 54.0' = 33.4 ppm
				55.5' - 57.0' - Silty Sand (SM), Gley1 4/1 light green gray, saturated, medium dense, moderate cementing	-56 56 -57		56.0' = 45.0 ppm
60				57.0' - 60.0' - Silty Sand (SM), Gley1 4/1 light green gray, saturated, medium dense, moderate cementing	57		58.0' = 48 ppm
				60.0' - 64.5' - Silty Sand (SM), Complete conglomerate, binded shells, 10YR 7/1 light gray, wet, very hard/solid, cemented shells	-60 60		60.0' = 152 ppm 62.0' = 109 ppm 64.0' = 9.1 ppm
65				64.5' - 67.0' - Silty Sand (SM), Medium sand, poorly graded, 10YR 5/1 dark gray, moist/saturated, very loose, homogenous *Aquaseal at 76.0' bgs	-65 65		66.0' = 11.1 ppm
70							68.0' = 40.2 ppm 70.0' = 13.7 ppm 72.0' = 23 ppm
75							74.0' = 62 ppm

CH2MHILL

Well Number: GW47IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/13/05 9:15 to 1:20

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
					-77		76.0' = 4.1 ppm
				77.0' - 84.0' - Silty Sand (SM), Medium sand, poorly graded, 10YR 5/1 dark gray, moist/saturated, very loose, homogenous	77		78.0' = .7 ppm
80							80.0' = .9 ppm
							82.0' = .9 ppm
					-84		84.0' = 1.0 ppm
85				84.0' - 87.0' - Silty Sand (SM), Gley 4/1 dark greenish gray, saturated, medium dense, numerous shells/fossils	84		86.0' = 1.4 ppm
					-87		
				87.0' - 100.0' - Silty Sand (SM), Medium sand, poorly graded Gley 4/1 dark greenish gray, saturated, loose to very loose, very homogenous, trace shells/fossils	87		88.0' = .9 ppm
90				*Set screen from 100.0' - 90.0' bgs			90.0' = 1.1 ppm
							92.0' = 1.2 ppm
							94.0' = 1.4 ppm
95							96.0' = 2.5 ppm
							98.0' = 1.4 ppm
					-100		
100				End of Boring at 100.0' bgs	100		100.0' = 1.8 ppm
				End of Log			

CH2MHILL

Well Number: GW48IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/11/05 2:55 to 5:15

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
0				Ground Surface	0		
				0 - 3.0' - Silty Sand (SM), Medium sand, 10YR 8/3 very pale brown, very loose	0 -1 1		0' - 3.0' = 0.00 ppm
				3.0' - 7.0' - Silty Sand (SM), Medium sand with 10% - 15% - 20% silt, 10YR 5/6 yellowish brown, moist, medium dense	-3 3		3.0' - 7.0' = 0.00 ppm
5					-7		
				7.0' - 10.0' - Silty Sand (SM), Medium sand, 10YR 6/8 yellowish yellow, moist, loose	7		7.0' - 10.0' = 0.0 ppm
				10.0' - 15.0' - Silty Sand (SM), Some organic - wet, 10YR 2/2 very dark brown, moist, very loose	-10 10		10.0' - 15.0' = 0.00 ppm
15				15.0' - 17.0' - Silty Sand (SM), Medium sand, 10YR 5/6 yellowish brown, wet, loose	-15 15		15.0' - 17.0' = 0.00 ppm
				17.0' - 20.0' - Silty Sand (SM), Medium sand, 10YR 5/6 yellowish brown, wet, loose	-17 17		17.0' = 0.00 ppm
20							21.0' = 2.2 ppm
				22.0' - 26.5' - Silty Sand (SM), 90% medium sand, poorly graded, 10YR 7/1 light gray, wet	-22 22		23.0' = 4.0 ppm
25							

CH2MHILL

Well Number: GW48IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/11/05 2:55 to 5:15

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
					-26		
				26.0' - 27.0' - Clayey Silt (ML), 10 - 15% fine sand, 10YR 4/1 dark gray, moist, stiff, slight plastic	26		
					-27		
					27		27.0' = 6.6 ppm
				27.0' - 37.0' - Silty Sand (SM), 10 - 15% silt, 80% medium sand, 10YR 3/1 very dark gray, saturated, loose to medium dense, homogenous			
30							31.0' = 2.9 ppm
							32.5' = 6.0 ppm
							33.5' = 8.1 ppm
35							35.0' = 17.2 ppm
							36.0' = 21.2 ppm
					-37		
				37.0' - 45.5' - Silty Sand (SC), 10 - 15% silt, 80% medium sand, 10YR 3/1 very dark gray, saturated, loose to medium dense, homogenous but at 43.0', 4" layer of clayey sand	37		38.0' = 31 ppm
							39.5' = 38 ppm
40							41.0' = 26 ppm
							43.0' = 23.0 ppm
							44.0' = 22.0 ppm
45					-46		
				45.5' - 47.0' - Silty Sand (SM), Gley1 4/1 greenish gray, wet, dense, many shells/fossils	46		46.0' = 26 ppm
					-47		
				47.0' - 53.0' - Silty Sand (SM), Medium sand, 10YR 4/1 dark gray, saturated, medium dense	47		48.0' = 30 ppm
							49.0' = 14.2 ppm
50							

CH2MHILL

Well Number: GW48IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/11/05 2:55 to 5:15

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
					-53		51.5' = 11.8 ppm 52.0' = 16.0 ppm
				53.0' - 57.0' - Silty Sand (SM), Gley 4/1 dark greenish gray, saturated, dense, numerous fossils, shells	53		53.0' = 22.3 ppm
55							55.0' = 16 ppm
					-57		
				57.0' - 60.0' - Silty Sand (SM), Gley 4/1 dark greenish gray, saturated, dense, numerous fossils, shells, medium cementing	57		57.0' = 18 ppm 58.0' = 67 ppm
					-60		
60				60.0' - 61.5' - Silty Sand (SM), Gley 4/1 dark greenish gray, saturated, dense, numerous fossils, shells, increase to medium/heavy cementing	60		60.0' = 71 ppm 61.0' = 74 ppm
					-62		
				61.5' - 65.5' - Completely cemented conglomerate, shells with silty sand (SM), 10YR 7/1 light gray, wet/dry, hard, very hard	62		62.0' = 4.5 ppm 64.0' = 12 ppm
65							
					-66		
				65.5' - 67.0' - Silty Sand (SM), Medium sand, 10YR 5/1 gray, saturated, loose	66		66.0' = 6 ppm
					-67		
				67.0' - 74.0' - Silty Sand (SM), Medium sand, poorly graded, 10YR 5/1 gray, wet, moist, loose, very homogenous	67		68.0' = 2.1 ppm 69.0' - 71.0' = 1.1 ppm
70							71.0' - 75.0' = 1.4 ppm
					-74		
					74		
75							

CH2MHILL

Well Number: GW48IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/11/05 2:55 to 5:15

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
				74.0' - 77.0' - Silty Sand (SM), Medium sand, poorly graded, 10YR 5/1 gray, wet, moist, loose, very homogenous but Gley1 4/1 dark greenish gray, trace fossils, still loose	-76 / 76		
				Will set seal at 76.0' bgs	-77 / 77		77.0' = 1.4 ppm
				77.0' - 79.0' - Silty Sand (SM), Medium sand, poorly graded, 10YR 5/1 gray, wet, moist, loose, very homogenous but Gley1 4/1 dark greenish gray, trace fossils, still loose			78.0' = 1.6 ppm
					-79 / 79		
80				79.0' - 87.0' - Silty Sand (SM), Medium sand, poorly graded, 10YR 6/1 gray, moist, saturated, loose, homogenous			80.0' = 1.6 ppm
							82.0' = 1.2 ppm
							84.0' = 1.8 ppm
85							86.0' = 2.8 ppm
					-87 / 87		87.0' = 1.8 ppm
				87.0' - 96.0' - Silty Sand (SM), Medium sand, poorly graded, 10YR 6/1 gray, moist, saturated, loose, homogenous, trace fossil, slight hardening at 96.0'			89.0' = 3.0 ppm
90							90.0' = 2.8 ppm
							92.0' = 4.4 ppm
							94.0' = 4.0 ppm
95							
					-96 / 96		96.0' = 3.9' ppm
				96.0' - 100.0' - Silty Sand (SM), 10 - 15% silt/crushed shells, Gley1 8/1 light greenish gray, saturated, dense, slight crumbly, numerous shells/fossils			98.0' = 2.3 ppm
					-100 / 100		
100				End of Boring at 100.0' bgs End of Log			100.0' = 2.1 ppm

CH2MHILL

Well Number: GW49IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/11/05 9:45 to 1:00

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
				Ground Surface	0		
0					0		0' - 3.0' = 0.00 ppm
				0 - 7.0' - Silty Sand (SM), Medium sand, 10YR 2/1 black, moist, very loose			
					-3		
	1	0.0 7.0		3.0' - 7.0' - Silty Sand (SM), 15 - 20% silt, 10YR 5/6 yellow brown, moist, medium dense	3		3.0' - 7.0' = 0.00 ppm
5							
					-7		
				7.0' - 9.0' - Silty Sand (SM), 10 - 15% silt, 10YR 5/8 brown, moist, medium dense	7		7.0' - 10.0' = 0.0 ppm
					-9		
				9.0' - 12.0' - Silty Sand (SM), 80% medium sand, 5 - 10% silt, 10YR 6/6 brown yellow, very loose	9		9.0' - 12.0' = 0.00 ppm
10							
					-12		
	2	7.0 17.0		12.0' - 13.0' - Clayey Silt (ML), 10YR 5/6, moist, medium stiff, slight plastic	12		12.0' - 13.0' = 0.00 ppm
					-13		
				13.0' - 17.0' - Silty Sand (SM), 80% - 90% medium sand, 10YR 7/1 light gray, moist, very loose	13		13.0' - 17.0' = 0.0 ppm
15							
					-17		
				17.0' - 19.0' - Silty Sand (SM), 80% - 90% medium sand, 10YR 7/1 light gray, moist, very loose	17		18.0' = 0.00 ppm
					-19		
				19.0' - 22.0' - Silty Sand (SM), 7.5YR 4/6 strong brown, wet, medium loose	19		
20							
					-22		
	3	17.0 27.0		22.0' - 27.0' - Silty Sand (SM), 90% medium sand, 10YR 6/1 gray, saturated, very loose, some reduced iron color	22		24.0' = 1.4 ppm
25							

CH2MHILL

Well Number: GW49IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/11/05 9:45 to 1:00

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
					-27		26.0' = 1.8 ppm
				27.0' - 29.0' - Silty Sand (SM), 90% medium sand, 10YR 6/1 gray, saturated, very loose, some reduced iron color	27		28.0' = 1.4 ppm
					-29		
				29.0' - 31.25' - Sandy Silt (ML), 10 - 25% medium sand, 10YR 2/1 very dark gray, saturated, medium dense, slight plastic	29		
30							31.0' = 1.9 ppm
	4	27.0 37.0			-32		
				32.0' - 35.0' - Silty Sand (SM), Medium sand, 10YR 5/6 yellowish brown, saturated, loose	32		34.0' = 0.8 ppm
35					-35		
				35.0' - 37.0' - Transition into (SM), 10YR 4/1 dark gray, saturated, loose, homogenous	35		36.0' = 1.4 ppm
					-37		
				37.0' - 45.5' - Silty Sand (SM), Medium sand, 10YR 4/1 dark gray, saturated, loose, homogenous	37		38.0' = 1.8 ppm
40							40.0' = 2.1 ppm
	5	37.0 47.0					42.0' = 4.2 ppm
							43.0' = 8.6 ppm
							44.0' = 29.8 ppm
45							45.0' = 27.6 ppm
					-46		
				45.5' - 47.0' - Sandy Silty (ML), 10YR 4/1 dark gray, saturated, medium dense	46		46.5' = 22.4 ppm
					-47		
				47.0' - 53.0' - Sandy Silty (ML), 10YR 4/1 dark gray, saturated, medium dense, trace fossils/shells	47		
50							50.0' = 18.9 ppm

CH2MHILL

Well Number: GW49IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/11/05 9:45 to 1:00

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
55	6	47.0 57.0		53.0' - 57.0' - Silty Sand (SM), Increasing to 15% silt, 10YR 4/1 dark gray, saturated, medium dense	-53 53		52.0' = 14.2 ppm 54.0' = 8.9 ppm 56.0' = 9.2 ppm
60	7	57.0 67.0		57.0' - 60.0' - Silty Sand (SM), Increasing to 15% silt, 10YR 4/1 dark gray, saturated, medium dense but moderate cementing 60.0' - 63.8' - Silty Sand (SM), Increasing to 15% silt, 10YR 4/1 dark gray, saturated, medium dense, increse in cementing	-57 57 -60 60		58.0' = 18.9 ppm 61.5' = 55.2 ppm
65				63.0' - 67.0' - Silty Sand (SM), 10YR 7/1 light gray, saturated, very hard, solid complete cementing, numerous shells/fossils	-63 63		63.0' = 88 ppm 65.0' = 154 ppm 66.0' = 122 ppm
70	8	67.0 77.0		67.0' - 77.0' - Silty Sand (SM), 90% medium sand, 10YR 5/1 gray, saturated/wet, very loose, very homogenous	-67 67		68.0' = 81.0 ppm 70.0' = 72 ppm 72.0' = 108 ppm
75							

CH2MHILL

Well Number: GW49IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/11/05 9:45 to 1:00

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
				Seal set at 76.0' bgs to isolate upper aquifer	-76 76 -77		76.0' = 145 ppm
				77.0' - 85.0' - Silty Sand (SM), 90% medium sand, 10YR 5/1 gray, saturated/wet, very loose, very homogenous	77		78.0' = 28 ppm
80							80.0' = 60 ppm
							81.0' = 51 ppm
	9	77.0 87.0					82.0' = 32 ppm
							84.0' = 29 ppm
85					-85		
				85.0' - 87.0' - Silty Sand (SM), 90% medium sand, 10YR 5/1 gray, saturated/wet, very loose, very homogenous, with slight cementing, trace shells	85		85.0' = 37 ppm
					-87		
				87.0' - 90.0' - Silty Sand (SM), Gley1 6/1 greenish gray, wet, dense, some cementing	87		87.0' = 32 ppm
							88.0' = 14 ppm
90					-90		
				90.0' - 100.0' - Silty Sand (SM), 95% medium sand, poorly graded, 10YR 4/1 dark gray, saturated, very loose, very homogenous	90		91.0' = 5.1 ppm
							93.0' = 2.9 ppm
95					-95		
				*Well screened from 100.0' - 90.0' bgs	95		95.0' = 2.9 ppm
							97.0' = 0.8 ppm
	10	97 100.0					99.0' = 1.0 ppm
100				End of Boring at 100.0' bgs End of Log	-100 100		

CH2MHILL

Well Number: GW50IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/12/05 8:45

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
				Ground Surface	0		
0				0 - 7.0' - Silty Sand (SM), Medium sand, 10YR 6/6 brownish yellow, moist, very loose, trace grass roots at 5.0' bgs	0		0' - 7.0' = 0.00 ppm
5					-7		
				7.0' - 14.0' - No recovery, stripped out of casing	7		7.0' - 17.0' = 0.00 ppm
10							
					-14		
				14.0' - 17.0' - Silty Sand (SM), Medium sand, 10YR 5/4 yellowish brown, moist, very loose	14		14.0' = 0.00 ppm
15					-17		
				17.0' - 20.0' - Silty Sand (SM), Medium sand, 10YR 5/4 yellowish brown, moist, very loose	17		18.0' = 0.00 ppm
					-20		
20				20.0' - 24.5' - Silty Sand (SM), Medium 10YR 3/2 dark brown, saturated, loose	20		20.0' = 0.00 ppm
							22.0' = 0.00 ppm
							24.0' = 1.0 ppm
25							

CH2MHILL

Well Number: GW50IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/12/05 8:45

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
				26.5' - 27.0' - Silty Sand (SM), Poorly graded, medium sand, 10YR 8/3 pale brown, saturated, very loose	-27 27		26.0' = 1.1 ppm
				27.0' - 30.0' - Silty Sand (SM), Medium sand 10 - 15% silt, 10YR 7/8 yellow, saturated, medium dense			28.5' = 6.8 ppm
30				30.0' - 34.0' - Silty Sand (SM), Medium sand, 10 - 15% silt, 10YR 7/1 light gray, saturated, medium dense	-30 30		30.0' = 1.1 ppm
							32.0' = 2.2 ppm
					-34 34		34.0' = 1.1 ppm
35				34.0' - 37.0' - Silty Sand (SM), 10 - 15% silt, 10YR 6/6 brown yellow, saturated, loose			36.0' = 0.9 ppm
					-37 37		37.0' = 1.5 ppm
				37.0' - 39.0' - Silty Sand (SM), Medium sand, 7.5YR 6/1 reddish yellow, saturated, loose			
					-39 39		39.0' = 1.6 ppm
40				39.0' - 47.0' - Silty Sand (SM), Medium sand, approximately 10% silt, 10YR 9/1 dark gray, saturated, loose, homogenous			41.0' = 6.2 ppm
							43.0' = 9.3 ppm
45							45.0' = 19.1 ppm
					-47 47		47.0' = 37.2 ppm
				47.0' - 57.0' - Silty Sand (SM), Medium sand, approximately 10% silt, 10YR 9/1 dark gray, saturated, loose, homogenous, slight increase in silt to 15 - 20% at 52.0' bgs			48.0' = 6.8 ppm
50							50.0' = 35.4 ppm

CH2MHILL

Well Number: GW50IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/12/05 8:45

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
55					-57		52.0' = 21.6 ppm 54.0' = 37.8 ppm 56.0' = 48.0 ppm
60				57.0' - 65.0' - Silty Sand (SM), 15 - 20% silt, Gley1 4/1 dark greenish gray, saturated, dense, shells/fossils, some light mottling at 64.0' - 65.0'	57		58.0' = 73 ppm 60.0' = 26 ppm 62.0' = 35 ppm 64.0' = 15.2 ppm
65				65.0' - 67.0' - Silty Sand (SM), Conglomerate 10YR 7/1 light gray, saturated, very hard, fully cemented	-65 65 -67		66.0' = 16.1 ppm
70				67.0' - 68.0' - Continued cementing 68.0' - 77.0' - Silty Sand (SM), Medium sand, poorly graded, 10YR 3/1 gray, wet, loose to very loose, very homogeneous, trace shells/fossils *will set seal at 76.0'	67 -68 68		68.0' = 35.4 ppm 70.0' = 25.5 ppm 72.0' = 21.4 ppm
75							74.0' = 24.2 ppm

CH2MHILL

Well Number: GW50IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Roto Sonic SRO-75
Sampling Method:
Logged by: Ben Claus
Start/Finish Date: 12/12/05 8:45

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
					-77		76.0' = 17.8 ppm
				77.0' - 86.0' - Silty Sand (SM), Medium sand, poorly graded, 10YR 3/1 gray, wet, loose to very loose, very homogeneous, trace shells/fossils, slight increase in shells	77		78.0' = 12.7 ppm
80							80.0' = 15.5 ppm
							82.0' = 32.4 ppm
							84.0' = 21.9 ppm
85					-86		
				86.0' - 88.0' - Silty Sand (SM), Gley 4/1 dark greenish gray, wet, medium dense, homogenous shells fossils	86		86.0' = 15.3 ppm
					-87		
				87.0' - 100.0' - Silty Sand (SM), 90% medium sand, 10YR 8/1 gray, silt/saturated, loose, trace shells/fossils, very homogenous	87		88.0' = 20.6 ppm
				*Set screen from 100.0' - 90.0' bgs			
90							90.0' = 58.1 ppm
							92.0' = 16.8 ppm
							94.0' = 7.1 ppm
95							96.0' = 22.3 ppm
							98.0' = 25.6 ppm
					-100		
100				End of Boring at 100.0' bgs	100		100.0' = 30.4 ppm
				End of Log			

CH2MHILL

Well Number: 6-GW51IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Rotosonic SRO-75
Sampling Method:
Logged by: Ben Claus'
Start/Finish Date: 12/12/05 13:45 to 17:15

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
				Ground Surface	0		
0				0.0'-7.0' - Silty Sand (SM), Medium sand, 10 YR 7/4, pale brown, dry/moist, very loose	0		8.5" Wellhead protection cover 2' X 2' Concrete pad
		H. Auger					Type of well - 2-inch ID/ Schedule 40 PVC
5							Grout - Portland Type 1 w/bentonite Bentonite chips - 3/8" diameter
					-7		
				7.0'-10.0' - Silty Sand (SM), Medium sand, 7.5 YR 6/8, reddish yellow, moist, medium density	7		
10					-10		
		Macrocore		10.0'-13.0': Silty Sand (SM), Medium sand, 10YR 6/8, brownish yellow, medium stiff	10		
					-13		
				13.0'-15.5' - Silty Sand (SM), Medium sand with 10-15% silt, 10YR 6/8, brownish yellow, medium dense, moist	13		
15					-16		Screen set from 150 bgs to 14.5 bgs
				15.5' - 17.0' - Clayey Sand (ML) with 10-15% fine sand, 10 YR 6/8, brownish yellow, medium stiff, plastic	16		
					-17		
				17.0' - 19.0' - Silty Sand (SM) Medium sand, 10YR 3/1, very dark gray	17		
					-19		Filter pack - #2 Sand
				19.0' - 22.0' - Silty Sand (SM) Medium sand, 10 YR 5/1, gray, saturated, loose	19		PID measurement were taken every 2 feet from 0 to 20 ft bgs and equaling 0.0 ppm.
20							
		Macrocore			-22		20.0' = 0.9 ppm 21.0' = 1.5 ppm
				22.0' - 27.0' - Silty Sand (SM) Medium sand, 10YR 7/1, light gray, saturated, very loose	22		23.0' = 2.0 ppm
25							25.0' = 1.5 ppm
					-27		27.0' = 2.1 ppm
				27.0' - 29.0' - Clayey Silt (ML) 10- 15% fine sand, 10YR6/8, brownish yellow, wet, dense/stiff, slight plastic	27		28.0' = 0.9 ppm
					-29		
					29		
30							

Well Number: 6-GW51IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Rotosonic SRO-75
Sampling Method:
Logged by: Ben Claus'
Start/Finish Date: 12/12/05 13:45 to 17:15

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
				29.0' - 34.5' - Silty Sand (SM) Medium sand, 10-15% silt, 10YR 6/6, yellowish brown, saturated loose	-35		31.0' = 1.1 ppm 33.0' = 2.4 ppm 34.0' = 3.8 ppm
35				34.5' - 53.0' - Silty Sand (SM) Medium sand, poorly graded, 10YR 4/1, dark gray, saturated, loose	35		36.0' = 9.0 ppm 38.0' = 3.1 ppm
40							40.0' = 14.5 ppm 42.0' = 28.9 ppm 43.0' = 24 ppm 44.0' = 31.6 ppm
45							46.0' = 16.1 ppm 48.0' = 23.7 ppm
50							50.0' = 20.1 ppm 52.0' = 15.5 ppm
					-53		
				53.0' - 57.0' - Silty Sand (SM) 10-15% silt, gley 1 6/1, greenish gray, moist, very dense, stiff, numerous fossils/shells	53		54.0' = 19.8 ppm
55							56.0' = 41.2 ppm
					-57		
				57.0' - 63.0' - Silty Sand (SM) Similar to 53.0' to 57.0' but less shells, more 10YR 4/1, gray	57		58.0' = 25.6 ppm
60							60.0' = 70.7 ppm

Well Number: 6-GW51IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Rotosonic SRO-75
Sampling Method:
Logged by: Ben Claus'
Start/Finish Date: 12/12/05 13:45 to 17:15

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
					-63		62.0' = 85.8 ppm
65				63.0' - 67.0' - Silty Sand (SM) Conglomerate, very hard, 10 YR 7/1, light gray, saturated, fully cemented shells	63		64.0' = 52.2 ppm
					-67		66.0' = 75.0 ppm
				67.0' - 77.0' - Silty Sand (SM) Medium sand, poorly graded, 10YR 5/1, gray, wet/saturated, loose to very loose	67		67.0' = 59.2 ppm
70							68.0' = 18.6 ppm
							70.0' = 24.3 ppm
							72.0' = 19.5 ppm
75							74.0' = 23.0 ppm
							76.0' = 17.9 ppm
					-77		77.0' = 12.0 ppm
				77.0' - 84.0' - Silty Sand (SM) Similar to 67.0' to 77.0' with trace shells/fossils	77		78.0' = 35 ppm
80							80.0' = 84.7 ppm
							82.0' = 63.7 ppm
					-84		84.0' = 47.2 ppm
85				84.0' - 90.0' - Silty Sand (SM) Medium sand, 10-15% silt, gley 1 6/1, greenish gray, wet, medium density, many shells/fossils	84		86.0' = 29.2 ppm
							88.0' = 73.1 ppm
90					-90		90.0' = 49.2 ppm
					90		

Well Number: 6-GW51IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Rotosonic SRO-75
Sampling Method:
Logged by: Ben Claus'
Start/Finish Date: 12/12/05 13:45 to 17:15

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
95				90.0' - 100.0' - Silty Sand (SM) Medium sand, poorly graded, gley 4/1, dark greenish gray, wet/saturated, loose, trace shells/fossils			92.0' = 46.8 ppm 94.0' = 41.0 ppm 96.0' = 29.2 ppm 97.0' = 35.8 ppm 99.0' = 37.9 ppm
100					-100		
				End of Log	100		
105							
110							
115							
120							

CH2MHILL

Well Number: 6-GW52IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Rotosonic SRO-75
Sampling Method:
Logged by: Ben Claus'
Start/Finish Date: 12/10/05 11:00 to 14:45

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
				Ground Surface	0		
0				0'-2.0' - Silty sand (SM), black, 10 YR 2/1, moist, very loose	0 -2		8" Wellhead protection cover 2' X 2' Concrete pad
		H. Auger		2.0'-4.0 - Silty sand (SM), light grey, 10YR 7/1, moist, very loose, medium sand	2 -4		Type of well - 2-inch ID/ Schedule 40 PVC
5				4.0'-9.0' - Silty sand with 10- 15% silt, (SM), yellow brown, 10YR 5/6, moist, medium density, medium sand	4 -9		Grout - Portland Type 1 w/bentonite Bentonite chips - 3/8" diameter
10		Macrocore		9.0'-13.0' - Silty sand, (SM), yellow, 10YR 7/8, moist, very loose, medium sand	9 -14		
				13.5'-15.5' - Silty sand (SM), light grey, 10YR 7/1, moist, very loose, medium sand	14 -16		Screen set from 150 bgs to 14.5 bgs
15				15.5'-19.0' - Silty sand (SM), yellowish brown, 10YR 3/1, moist, very loose, medium sand	16 -19		Filter pack - #2 Sand
20		Macrocore		19.0'-24.0' - Silty sand (SM), yellowish brown, 10YR 6/8, saturated, very loose, 90% medium sand with trace coarse sand	19 -24		PID measured about every 2 feet from 0 to 24 ft bgs equal 0.0 ppm.
25				24.0-26.0 - Silty sand (SM), light grey, 10YR 7/1, saturated, very loose, 90% medium sand with trace coarse sand	24 -26		26.0' = 0.00 ppm
				26.0'-27.0' - Silty sand (SM), grey, 10YR 6/1, moist, plastic, medium stiff	26		
				27.0'-35.0' - Silty sand (SM), yellowish red, 10YR 5/8, saturated, loose			28.0' = 1.1 ppm 27.0' to 30.0' = 0.0 ppm
30							

Well Number: 6-GW52IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Rotosonic SRO-75
Sampling Method:
Logged by: Ben Claus'
Start/Finish Date: 12/10/05 11:00 to 14:45

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
							32.0' = 1.8 ppm
35					-35		
				35.0'-43.0' - Silty sand (SM), very dark grey, 10YR 3/1, saturated, loose, medium sand	35		35.0' = 1.7 ppm 36.0' = 5.2 ppm 37.0' = 1.4 ppm
40							40.0' = 2.2 ppm 41.0' = 4.2 ppm
					-43		
				43.0'-47.0' - Silty sand (SM), grey, 10 YR 5/1, saturated, hard, medium sand, heavy cementing with numerous shells/fossils	43		44.0' = 17.8 ppm
45							46.0' = 16.2 ppm
					-47		47.0' = 22.1 ppm
				47.0'-52.0' - Silty sand with 10-20% silt, (SM), dark gray, 10 YR 4/1, saturated, medium density, fine/medium sand	47		48.0' = 66 to 78 ppm
50							50.0' = 59 ppm
					-52		
				52.0'-57.0' - Silty sand with 10-20% silt, (SM), dark greenish grey, grey 4/1, wet, dense, fossils/shells, medium stiff	52		52.0' = 14.2 ppm 54.0' = 32.3 ppm
55							55.0' = 12.3 ppm
					-57		
				57.0'-60.0' - Silty sand (SM), grey, 10YR 3/1, saturated, hard to medium heavy, cementing with shells/fossils, medium sand	57		57.0' = 23 ppm 58.0' = 67 ppm
60					-60		
					60		60.0' = 78 ppm

CH2MHILL

Well Number: 6-GW52IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Rotosonic SRO-75
Sampling Method:
Logged by: Ben Claus'
Start/Finish Date: 12/10/05 11:00 to 14:45

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
				60.0'-63.0' - Silty sand (SM), grey, 10YR 3/1, saturated, hard to medium heavy, some with shells/fossils, medium sand, lessoning cementing	-63		63.0' = 78 ppm 64.0' = 88.2 ppm
65				63.0'-67.0' - Silty sand (SM), light gray, 10YR 7/1, saturated, very hard, complete cementing,shells/fossils	63 -67		65.0' = 95 ppm 66.0' = 89 ppm
				67.0'-77.0' - Silty sand (SM), grey, 10YR 5/1, saturated, very loose, very homogenous	67		67.0' = 76 ppm 68.0' = 55 ppm
70							70.0' = 60 ppm
							72.0' = 17.8 ppm
75							74.0' = 4.9 ppm
							76.0' = 1.1 ppm
					-77		
				77.0'-86.0' - Silty sand (SM), grey, 10YR 5/1, saturated, very loose, very homogenous, trace shells at 85 ft bgs	77		77.0' = 1.3 ppm 79.0' = 1.0 ppm
80							81.0' = 0.8 ppm
							84.0' = 0.8 ppm
85					-85		
				86.0'-87.0' - Silty sand (SM), grey, 10YR 5/1, saturated, very loose, very homogenous, increasing in shells	85 -87		86.0' = 1.0 ppm 87.0' = 0.9 ppm
				87.0'-100.0' - Silty Sand (SM), medium sand, poorly graded, 10YR 4/1, dark grey, loose to very loose, homogenous, trace shells	87		
90							90.0' = 1.4 ppm

Well Number: 6-GW52IW

Client: NAVFAC
Project: Site 82 Well Installation
Location: Camp Lejeune
Project Number: 328432

Driller: Prosonic
Drilling Method: Rotosonic SRO-75
Sampling Method:
Logged by: Ben Claus'
Start/Finish Date: 12/10/05 11:00 to 14:45

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
95							95.0' = 1.5 ppm
100					-100		100.0' = 0.9 ppm
				End of Log	100		
105							
110							
115							
120							

Appendix B

Groundwater Analytical Results

Appendix B: Groundwater Analytical Results
OU 2, Site 82
MCB Camp Lejeune, North Carolina

Station ID	IR06-DRW01					IR06-GW47IW				IR06-GW48IW				IR06-GW49IW			
Sample ID	IR06-DRW01-07A	IR06-DRW01-07B	IR06-DRW01-07B2	IR06-DRW01-07C	IR06-DRW01-07C2	IR06-GW47IW-07A	IR06-GW47IW-07B	IR06-GW47IW-07B2	IR06-GW47IW-07C	IR06-GW48IW-07A	IR06-GW48IW-07B	IR06-GW48IW-07B2	IR06-GW48IW-07C	IR06-GW49IW-07A	IR06-GW49IWD-07A	IR06-GW49IW-07B	IR06-GW49IW-07B2
Sample Date	02/01/07	04/18/07	06/13/07	08/14/07	08/14/07	02/01/07	04/19/07	06/13/07	08/14/07	02/01/07	04/18/07	06/14/07	08/15/07	02/02/07	02/02/07	04/18/07	06/14/07
Chemical Name																	
Volatile Organic Compounds (UG_L)																	
1,1-Dichloroethene	4.2 U	0.5 U	0.13 J	10 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.7 J	5.2	4.8	9.4	15	15 J	21 U	26
1,2-Dichloroethene (total)	NA	NA	NA	7 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanone	21 U	44	26	16	32	2.5 U	2.5 U	2.5 U	2.5 U	21 U	5.2 U	16 U	16 J	63 U	130 U	110 U	130 U
2-Hexanone	21 U	2.5 U	3.8	10 U	4.6	2.5 U	2.5 U	2.5 U	2.5 U	21 U	5.2 U	16 U	16 U	63 U	130 U	110 U	130 U
4-Methyl-2-pentanone	21 U	2.5 U	2.5 U	10 U	1.6 J	2.5 U	2.5 U	2.5 U	2.5 U	21 U	5.2 U	16 U	16 U	63 U	130 U	110 U	130 U
Acetone	21 U	2.5 U	42 B	21	78 B	2.5 U	2.5 U	1.3 BJ	4 B	21 U	5.2 U	24 B	22 B	63 U	130 U	110 U	280 B
Carbon disulfide	4.2 U	0.38 J	0.42 BJ	10 U	0.43 J	1	0.5 U	0.22 BJ	0.31 J	4.2 U	1 U	3.1 U	1.3 J	13 U	25 U	21 U	22 J
Chlorobenzene	4.2 U	0.5 U	0.5 U	10 U	0.11 J	0.5 U	0.5 U	0.5 U	0.5 U	4.2 U	1 U	3.1 U	3.1 U	13 U	25 U	21 U	25 U
Chloroform	4.2 U	9.2	3.4	10 U	0.64	0.59	0.5 U	0.5 U	0.5 U	4.2 U	1 U	3.1 U	3.1 U	13 U	25 U	21 U	25 U
Ethylbenzene	4.2 U	0.5 U	0.5 U	10 U	0.13 J	0.5 U	0.5 U	0.5 U	0.5 U	4.2 U	1 U	3.1 U	3.1 U	13 U	25 U	21 U	25 U
Methylene chloride	4.2 U	4.6	4.8 B	10 U	5.8 B	0.16 J	0.5 U	0.23 BJ	0.5 J	4.2 U	1 U	2.1 BJ	3.1 U	13 U	7.2 J	21 U	7.7 BJ
Tetrachloroethene	15	0.17 J	0.26 J	10 U	0.28 J	11	32 D	47	18	53	43	53	100	63	62	21 U	22 J
Toluene	4.2 U	0.5 U	0.19 J	10 U	0.5 J	0.5 U	0.5 U	0.12 J	0.5 U	4.2 U	1 U	3.1 U	3.1 U	13 U	25 U	21 U	7.8 J
Trichloroethene	160	2	2.2	1 J	1.9	5.8	6.2	5.3	5.5	120	42	40	69	1,000	830	21 U	1,500
Vinyl chloride	1.6 J	0.79	0.5 U	10 U	0.74	0.5 U	0.5 U	0.5 U	0.5 U	4.2 U	5.7	4.7	4.6	4.8 J	25 U	85	1,100
Xylene, total	4.2 U	0.5 U	0.5 U	10 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.2 U	1 U	3.1 U	3.1 U	13 U	25 U	21 U	25 U
cis-1,2-Dichloroethene	150	29 D	7.3	7 J	10	2.1	3	9.1	20	40	39	27	50	610	670	810 D	550
o-Xylene	4.2 U	0.5 U	0.5 U	10 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.2 U	1 U	3.1 U	3.1 U	13 U	25 U	21 U	25 U
trans-1,2-Dichloroethene	36	5	1.7	10 U	1.7	0.24 J	0.49 J	0.47 J	0.5	4.2	4.8	4.9	9.6	98	100	18 J	100
Total Metals (UG_L)																	
Iron	3,780 E	28,900 N	36,700	NA	16,600	1,240 E	1,630 N	1,570	1,270	105 E	360 N	239	178	194 E	207 E	3,470 N	11,600
Manganese	44.2 E	82.1	65.7 E	NA	60.9	106 E	80	74.7 E	61.6	9.4 BE	26.1	22.8 E	16.7	11.7 E	12 E	107	231 E
Dissolved Metals (UG_L)																	
Iron	87.4 B	26,900	34,000	NA	13,700 E	588	919	719	440 E	10 B	76.3 B	78.3 B	71.5 BE	51.6 B	54.7 B	875	12,500
Manganese	24.9	81.6	66.8	NA	52.3 E	104	78.8	73.8	54.6 E	7.2 B	24	24.4	15.5 E	11	10.6	111	248
Wet Chemistry (MG_L)																	
Alkalinity	91.9	587	499	NA	586	101	123	110	97.5	156	141	137	122	118	118	380	1,540
Bromide	0.1 U	2.89	0.66	NA	NA	0.1 U	0.1 U	0.1 U	NA	0.1 U	0.1 U	0.1 U	NA	0.1 U	0.1 U	7.94	6.4
Chloride	3.7	2.8	3.12	NA	2.03	4.32	4.87	4.35	3.95	5.15	5.26	4.02	4.27	5.03	4.78	3.3	5.14
Ethane	0.002 U	7.00E-04 J	NA	NA	4.00E-04 J	0.002 U	0.002 U	NA	0.002 U	0.002 U	0.002 U	NA	0.002 U	0.002 U	7.00E-05 J	0.002 U	NA
Ethene	0.002 U	0.002 U	NA	NA	0.002 U	8.00E-04 J	0.002 U	NA	3.00E-04 J	0.002 U	0.002 U	NA	8.00E-05 J	0.002 U	0.002 U	0.002 U	NA
Methane	4.00E-04 JB	0.002	NA	NA	0.079 BD	6.00E-04 JB	9.00E-04 J	NA	0.005 B	4.00E-04 JB	6.00E-04 J	NA	1.00E-03 B	5.00E-04 JB	5.00E-04 JB	0.002	NA
Nitrite	0.05 U	8.94	6.44	NA	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.815	8.84
Sulfate	5.46	1.38 B	5 U	NA	0.185 B	0.92 B	2.36 B	1.85 B	2.18 B	2.15 B	2.3 B	1.63 B	2.01 B	5.58	5.41	2.65 B	1.09 B
Sulfide	1 U	1 U	1 U	NA	1	0.6 B	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total organic carbon (TOC)	5 U	470	332	NA	310	5 U	2.02 B	5 U	2.4 B	5 U	5 U	5 U	5 U	5 U	5 U	392	845

Notes:
Data is unvalidated
U- Analyte not detected
J- Reported value is estimated
B- (Organics) Possible blank contamination
B- (Inorganics) Below detection limit
E- (Organics) Concentration exceeded calibration range
E- (Inorganics) Estimated concentration due to interference
D- Diluted result
N- Spiked smapled recovery not within control limits
Shading represents detection
NA- Not analyzed

Appendix B: Groundwater Ana
OU 2, Site 82
MCB Camp Lejeune, North Ca

Station ID	IR06-GW50IW							IR06-GW51IW					IR06-GW52IW			
Sample ID	IR06-GW49IWD-07B2	IR06-GW49IW-07C	IR06-GW50IW-07A	IR06-GW50IW-07B	IR06-GW50IWD-07B	IR06-GW50IW-07B2	IR06-GW50IW-07C	IR06-GW51IW-07A	IR06-GW51IW-07B	IR06-GW51IW-07B2	IR06-GW51IW-07C	IR06-GW51IWD-07C	IR06-GW52IW-07A	IR06-GW52IW-07B	IR06-GW52IW-07B2	IR06-GW52IW-07C
Sample Date	06/14/07	08/15/07	02/02/07	04/19/07	04/19/07	06/13/07	08/14/07	02/01/07	04/19/07	06/13/07	08/14/07	08/14/07	02/01/07	04/18/07	06/14/07	08/15/07
Chemical Name																
Volatile Organic Compounds (UG_L)																
1,1-Dichloroethene	22 J	12 J	130 U	50 U	100 U	250 U	50 U	13 U	100 U	250 U	50 U	250 U	7.2	5	7.2	11
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanone	280 J	400	630 U	250 U	500 U	1,300 U	250 U	63 U	500 U	1,300 U	250 U	1,300 U	21 U	13 U	31 U	2.5 U
2-Hexanone	500 U	250 U	630 U	250 U	500 U	1,300 U	250 U	63 U	500 U	1,300 U	250 U	1,300 U	21 U	13 U	31 U	2.5 U
4-Methyl-2-pentanone	500 U	250 U	630 U	250 U	500 U	1,300 U	250 U	63 U	500 U	1,300 U	250 U	1,300 U	21 U	13 U	31 U	2.5 U
Acetone	900 B	360 B	630 U	250 U	500 U	1,900 B	270 B	63 U	500 U	1,500 B	240 JB	650 JB	21 U	13 U	46 B	3.4 B
Carbon disulfide	22 BJ	50 U	130 U	50 U	100 U	73 BJ	50 U	13 U	100 U	59 BJ	50 U	250 U	4.2 U	2.5 U	1.6 BJ	0.2 J
Chlorobenzene	100 U	50 U	130 U	50 U	100 U	250 U	50 U	13 U	100 U	250 U	50 U	250 U	4.2 U	2.5 U	6.3 U	0.5 U
Chloroform	100 U	50 U	130 U	50 U	100 U	250 U	50 U	13 U	100 U	250 U	50 U	250 U	4.2 U	2.5 U	6.3 U	0.5 U
Ethylbenzene	100 U	50 U	28 JB	50 U	100 U	250 U	50 U	2.6 JB	100 U	250 U	50 U	250 U	4.2 U	2.5 U	6.3 U	0.5 U
Methylene chloride	41 BJ	50 U	130 U	50 U	100 U	100 BJ	50 U	13 U	100 U	100 BJ	50 U	250 U	4.2 U	2.5 U	2.8 BJ	0.5 U
Tetrachloroethene	100 U	50 U	50 J	50 U	61 J	130 J	42 J	110	87 J	220 J	210	210 J	96	130 D	220	240 R
Toluene	100 U	50 U	130 U	50 U	100 U	250 U	50 U	13 U	100 U	250 U	50 U	250 U	4.2 U	2.5 U	6.3 U	0.11 J
Trichloroethene	1,600	1,100	8,300	1,300	3,200	7,400	4,500 D	3,800	3,200 D	6,900	8,000 D	6,200	150	97	130	130 D
Vinyl chloride	990	1,300	130 U	50 U	100 U	250 U	21 J	5.5 J	100 U	250 U	17 J	250 U	4.2 U	2.8	6.3 U	4.1
Xylene, total	100 U	50 U	150 B	50 U	100 U	250 U	50 U	14 B	100 U	250 U	50 U	250 U	4.2 U	2.5 U	6.3 U	0.1 J
cis-1,2-Dichloroethene	540	500	1,700	790	1,200	1,900	2,800 D	520	1,600	1,000	1,700	990	130	67	74	100 D
o-Xylene	100 U	50 U	130 U	50 U	100 U	250 U	50 U	13 U	100 U	250 U	50 U	250 U	4.2 U	2.5 U	6.3 U	0.1 J
trans-1,2-Dichloroethene	120	68	350	99	180	260	190	210	290	290	570	250	20	14	20	28
Total Metals (UG_L)																
Iron	12,500	8,540	871 E	875 N	860 N	929	564	542 E	919 N	750	606	655	510 E	433 N	476	273
Manganese	244 E	194	64 E	57.7	56.6	54.8 E	43.5	20.4 E	16.3	14.4 E	12	12.1	35.8 E	26.2	25.4 E	12.9
Dissolved Metals (UG_L)																
Iron	12,100	6,330 E	471	344	367	228	293 E	256	422	330	365 E	13,700 E	166	79.9 B	150	88.9 BE
Manganese	242	173 E	59.2	53.2	53.5	51.3	38.2 E	19.4	14.8	14.6	10.7 E	52.7 E	25.1	22.4	21.1	11.3 E
Wet Chemistry (MG_L)																
Alkalinity	1,550	1,760	93.5	103	108	99.7	89.4	83.1	108	94	86.9	80.9	158	153	143	121
Bromide	6.14	NA	0.1 U	0.1 U	0.1 U	0.1 U	NA	0.1 U	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U	NA
Chloride	4.68	3.22	7.6	6.72	7.4	5.08	4.81	6.32	6.97	5.48	5.05	5.16	5.23	5.33	4.71	4.72
Ethane	NA	0.002 U	2.00E-04 J	2.00E-04 J	0.002 U	NA	0.002 U	2.00E-04 J	0.002 U	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	0.002 U
Ethene	NA	6.00E-04 J	7.00E-04 J	6.00E-04 J	0.002 U	NA	2.00E-04 J	9.00E-04 J	0.002 U	NA	0.002 U	0.002 U	0.002 U	0.002 U	NA	0.002 U
Methane	NA	0.3 BD	5.00E-04 JB	0.003	0.003	NA	0.003 B	6.00E-04 JB	4.00E-04 J	NA	1.00E-03 JB	1.00E-03 JB	7.00E-04 JB	4.00E-04 J	NA	1.00E-03 JB
Nitrite	8.89	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Sulfate	1.2 B	0.95 B	5.85	4.98 B	5.11	4.09 B	4.87 B	4.53 B	5.39	4.42 B	5.03	5.04	3.54 B	3.33 B	2.61 B	2.98 B
Sulfide	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.6 B	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total organic carbon (TOC)	845	531	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

Notes:
Data is unvalidated
U- Analyte not detected
J- Reported value is estimated
B- (Organics) Possible blank contamination
B- (Inorganics) Below detection limit
E- (Organics) Concentration exceeded calibra
E- (Inorganics) Estimated concentration due t
D- Diluted result
N- Spiked smapled recovery not within contro
Shading represents detection
NA- Not analyzed